TECHNICAL GUIDELINES FOR PREPARING A POLLUTION CONTROL PLAN

Ontario

Ministry
of the
Environment

J. Bishop, Director
Water Resources Branch

TECHNICAL GUIDELINES
FOR PREPARING A
POLLUTION CONTROL PLAN

BY

URBAN DRAINAGE POLICY
IMPLEMENTATION COMMITTEE
TECHNICAL SUB-COMMITTEE NO. 2

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FOREWORD

The Pollution Control Planning (PCP) Guidelines were prepared by the Urban Drainage Policy Implementation Committee. The Committee recommended that the Ministry of the Environment consider these guidelines as an implementation mechanism for its own policies with respect to control of pollution from a municipality.

The Ministry accepted the Committee's recommendation and initiated a province-wide program for water pollution control planning. These guidelines are distributed to assist municipalities and their agents in preparing cost-effective pollution control plans.

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ABSTRACT

The report provides advisory (planning and technical) guidelines for municipalities, consultants and regulatory agencies involved in the process of preparing a Pollution Control Plan (PCP).

The background leading to the PCP concept is presented. Basic water quality concepts are summarized and legislation and policies relevant to the PCP process are discussed. Suggestions for PCP implementation are also presented.

The technical aspects of PCP preparation including "developing" terms of reference, and the PCP cursory and detailed assessment stages are presented and, where possible, supported by examples. As well, pollution control alternatives for point and non-point sources are summarized and a decision analysis procedure enabling the selection of an optimum PCP is described. A suggested format for PCP reporting is provided and the preparation of PCP's is illustrated through a case history example.

CHAPTER 1

INTRODUCTION

1.1 Purpose and Audience of PCP Guidelines

The following are technical and planning guidelines that provide advice in the preparation of Pollution Control Plans. Although PCP implementation procedures are presented within the body of the guidelines these aspects are intended as suggestions.

The audience to which the guidelines are addressed is primarily comprised of municipal engineers, consultants and the staff of government ministries (e.g. MOE, MNR) and other agencies (e.g. Conservation Authorities). The document will also be of benefit to students with an interest in the planning and technical aspects of pollution control management.

1.2 Background

Since the signing of the Canada-Ontario Agreement (COA) on Great Lakes Water Quality (COA) in 1971, and the Canada-United States Agreement on Great Lakes Water Quality in 1972, the Province of Ontario has conducted or co-ordinated considerable research on pollution from both urban and non-urban sources. The Urban Drainage Subcommittee was formed to co-ordinate research into urban drainage management for the COA Technical Committee, while non-urban studies were conducted through the Pollution from Land Use Activities Reference Group (PLUARG) for the International Joint Commission.

In recognition of the seriousness and complexity of urban drainage problems the Urban Drainage Subcommittee commissioned the preparation of a "Manual of Practice for Urban Drainage" (COA, 1980a), and requested the formation of an Urban Drainage Policy Committee. The Urban Drainage Manual consolidates information on urban drainage problems and solutions identified by research in Ontario and elsewhere (particularly by the PL92-500 Section 208 programs in the U.S.) and formed the technical background for the Policy Committee in preparing a report entitled "Proposed Model Policies for Urban Drainage Management" (COA, 1980b).

More recently, implementation of the Urban Drainage Management Program was initiated through the Inter-Ministerial Urban Drainage Policy Implementation Committee (UDPIC). The program package resulting from UDPIC deliberations has the following key features:

- The recommendations of the Province on urban drainage planning and technical practice to be used in new urban developments.
- Master drainage plans and stormwater management plans are considered the most appropriate means for incorporating watershed constraints and implementing drainage control requirements in newly developing areas. These urban drainage plans are to be integrated with the normal land development process.
- Technical guidelines which provide examples of the best current practices in drainage design and erosion and sediment control are provided.
- Methods of streamlining and clarifying the review and approval process are provided.
- The need for the Province to provide continued technical support and training in technical aspects is outlined.
- Flexibility in application of the program is expected because the emphasis on local interests is ensured by transferring much of the planning responsibilities to municipalities, and by the inherent flexibility in the technical guidelines which present optional ways of achieving objectives.
- The program will ensure that planning of drainage systems will be co-ordinated and that design and construction will be cost-effective; the approval process will be speeded up, with the resulting effects of a higher level of protection against flooding and pollution; and promoting orderly development.

Pollution Control Planning would be carried out on an "as needed basis" separately from urban drainage planning such as Master Drainage and Stormwater Management plans preparation. The Pollution Control Plan would however, provide input to the urban drainage planning activities where multi-source water quality problems (particularly from wet weather sources) exist. Figure 1-1 illustrates the relationship of the PCP to urban drainage and land-use planning.

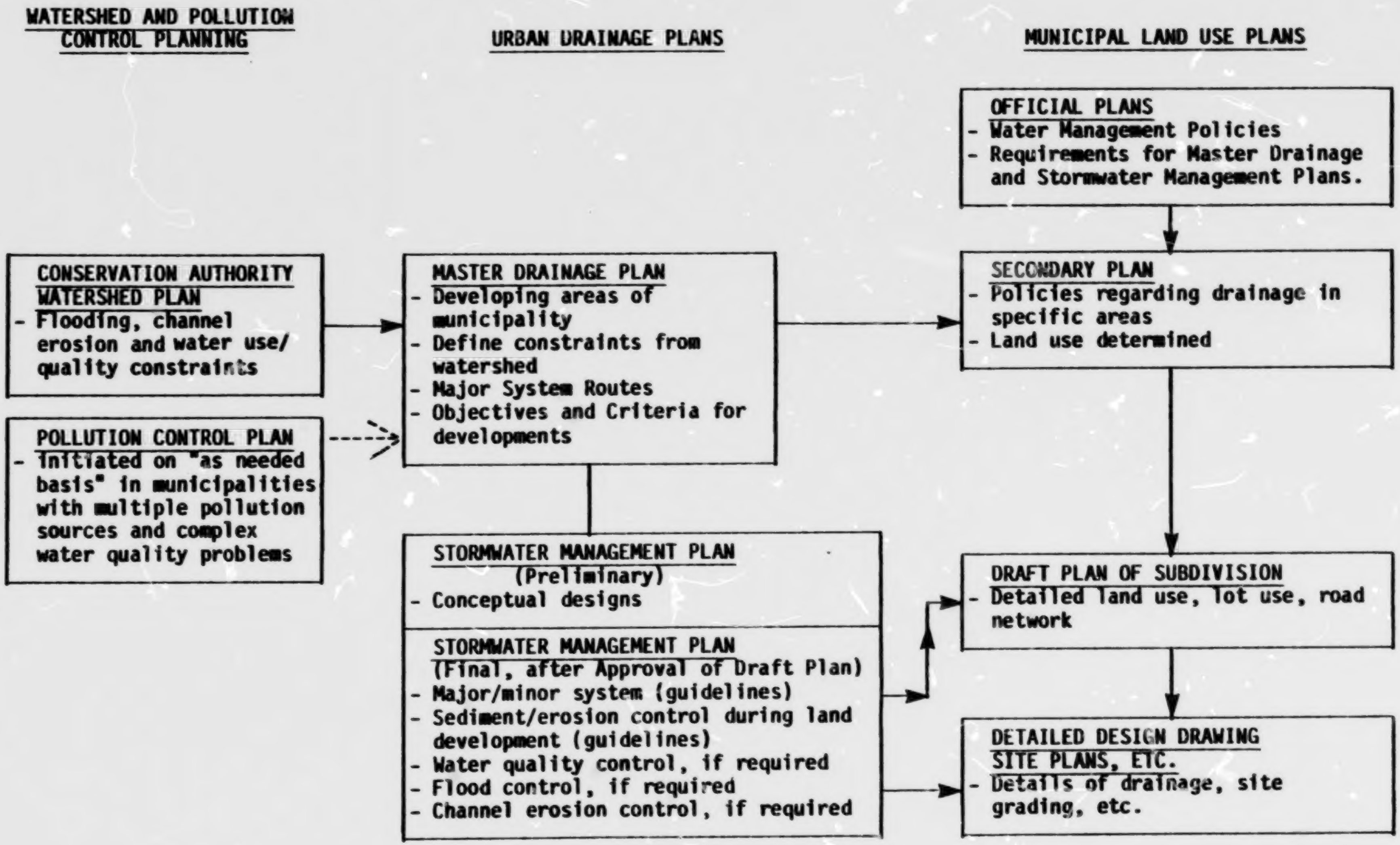

WATERSHED AND POLLUTION CONTROL PLANNING
URBAN DRAINAGE PLANS
MUNICIPAL LAND USE PLANS
OFFICIAL PLANS
- Water Management Policies
- Requirements for Master Drainage and Stormwater Management Plans.
CONSERVATION AUTHORITY WATERSHED PLAN
- Flooding, channel erosion and water use/quality constraints
MASTER DRAINAGE PLAN
- Developing areas of municipality
- Define constraints from watershed
- Major System Routes
- Objectives and Criteria for developments
SECONDARY PLAN
- Policies regarding drainage in specific areas
- Land use determined
POLLUTION CONTROL PLAN
- Initiated on "as needed basis" in municipalities with multiple pollution sources and complex water quality problems
STORMWATER MANAGEMENT PLAN (Preliminary)
- Conceptual designs
STORMWATER MANAGEMENT PLAN (Final, after Approval of Draft Plan)
- Major/minor system (guidelines)
- Sediment/erosion control during land development (guidelines)
- Water quality control, if required
- Flood control, if required
- Channel erosion control, if required
DRAFT PLAN OF SUBDIVISION
- Detailed land use, lot use, road network
DETAILED DESIGN DRAWING SITE PLANS, ETC.
- Details of drainage, site grading, etc.

FIGURE 1-1 - INTER-RELATIONSHIP BETWEEN URBAN DRAINAGE PLANNING, LAND USE PLANNING AND WATERSHED AND POLLUTION CONTROL PLANNING

1.3 **Objectives of the PCP**

The objectives of the PCP process are considered to be:

1) To define the cost-effective, environmentally and socially acceptable measures which will achieve the necessary levels of control over water-borne pollutant discharges from municipal, industrial and agricultural sources in order to protect beneficial water use.
2) To provide a framework which will facilitate municipal, industrial and agricultural pollution control planning and enable a greater degree of integration with other municipal planning and contemporary water management and planning processes.
3) To enable the Province to make the optimum allocation of capital funds for assisting the provision or upgrading of municipal wastewater conveyance and treatment facilities and drainage works.

Since other mechanisms exist for the control of discharges from industries or agriculture, the provisions of the PCP apply only to those cases where there exists a combination of municipal, industrial and agricultural discharges. It is not intended that industries or agricultural operations be required to prepare a PCP single-handed.

1.4 **Benefits of the PCP**

Sound pollution control management requires a planned comprehensive approach making cost-effective use of available technology. All relevant pollutant sources must be considered to provide thorough and effective solutions to water quality problems. The solutions must be integrated with contemporary water management activities as well as municipal facilities planning and operational programs. The PCP process is intended to provide the necessary framework to formulate management decisions affecting water pollution control expenditures. Through the PCP, the necessary technical, economic and public opinion data are structured for the benefit of the decision makers. The public consultation aspect of PCP implementation serves to gauge public perception of water management problems and enable incorporation of public concerns into action plans. Finally, the PCP documents, in a comprehensive manner, the future course of pollution control in a community. This enables both the municipality and the province to better estimate funding requirements and to place in context the impact of specific works. The following summarizes the major benefits of the PCP:

- Reduction in total cost of pollution control through the application of cost-effective management strategies combining both capital works and operational measures. It is expected that the cost savings will many times offset the direct cost of PCP implementation.
- Enhanced effectiveness of MOE Capital Grants Program (greater effect for same expenditure).
- Streamlining of pollution control administration. A master pollution control plan will be available to both the municipality and funding/approving agency. Value Engineering, E.A. and Capital Construction Grant Program requirements will be tied together with technical assessment. Overall costs of administration of these program requirements, net of PCP review and administration costs, should be reduced.
- More equitable distribution of pollution control costs.
- Enhanced water quality resulting from comprehensive analysis.
- Streamlined EA requirements for multi-project management plans.
- Enhanced MOE capital works decision process (i.e. greater certainty of making appropriate decisions).
- Increased municipal role in pollution control management and planning.
- Increased public awareness and public review of local pollution control management issues.

1.5 Terminology

Certain terms are used throughout this report; the most significant are defined below. Other technical terms are defined in the glossary in Appendix A.

PCP Cursory Assessment

The cursory assessment is the initial, and in many cases, the only study phase in PCP preparation. Pollutant sources, water uses, and where possible, management plans are identified and characterized for the study area. The scope of a cursory assessment is variable and will depend upon whether similar or complementary studies have been recently carried out in the particular municipality. Full use should be made of relevant prior studies.

Depending upon circumstances, the cursory assessment, as well as any subsequent assessment stages, may involve only a single party (i.e. single municipality) or may be the co-operative effort of a number of parties (e.g. upper and lower tier municipalities or a municipality and an agricultural concern).

The output from the cursory assessment stage will be in the form of a summary report.

PCP Detailed Assessment

If the cursory assessment does not adequately define the water quality problems and pollution control alternatives, a subsequent detailed assessment will be required. In the detailed assessment, additional data collection is undertaken, more sophisticated models (pollutant source and receiving water) are applied and inflow-infiltration problems receive further analysis. Detailed assessment findings are also presented in a summary report.

1.6 **Overview of PCP Preparation**

The elements involved in the formulation of a PCP will vary from case to case and will be dependent on several factors including:

i) whether the plan involves only a single party or is the co-operative effort of many parties,
ii) the importance and severity of water quality problems,
iii) the availability of water quality and pollutant source data, and
iv) the applicability and relevance of previous planning studies.

Figure 1-2 presents a flow chart diagraming the overall PCP process.

Following the initiation, terms of reference are prepared, any multi-party agreement are formulated and consultant(s) selected if necessary. Terms of reference establish the technical as well as the administrative basis of the PCP.

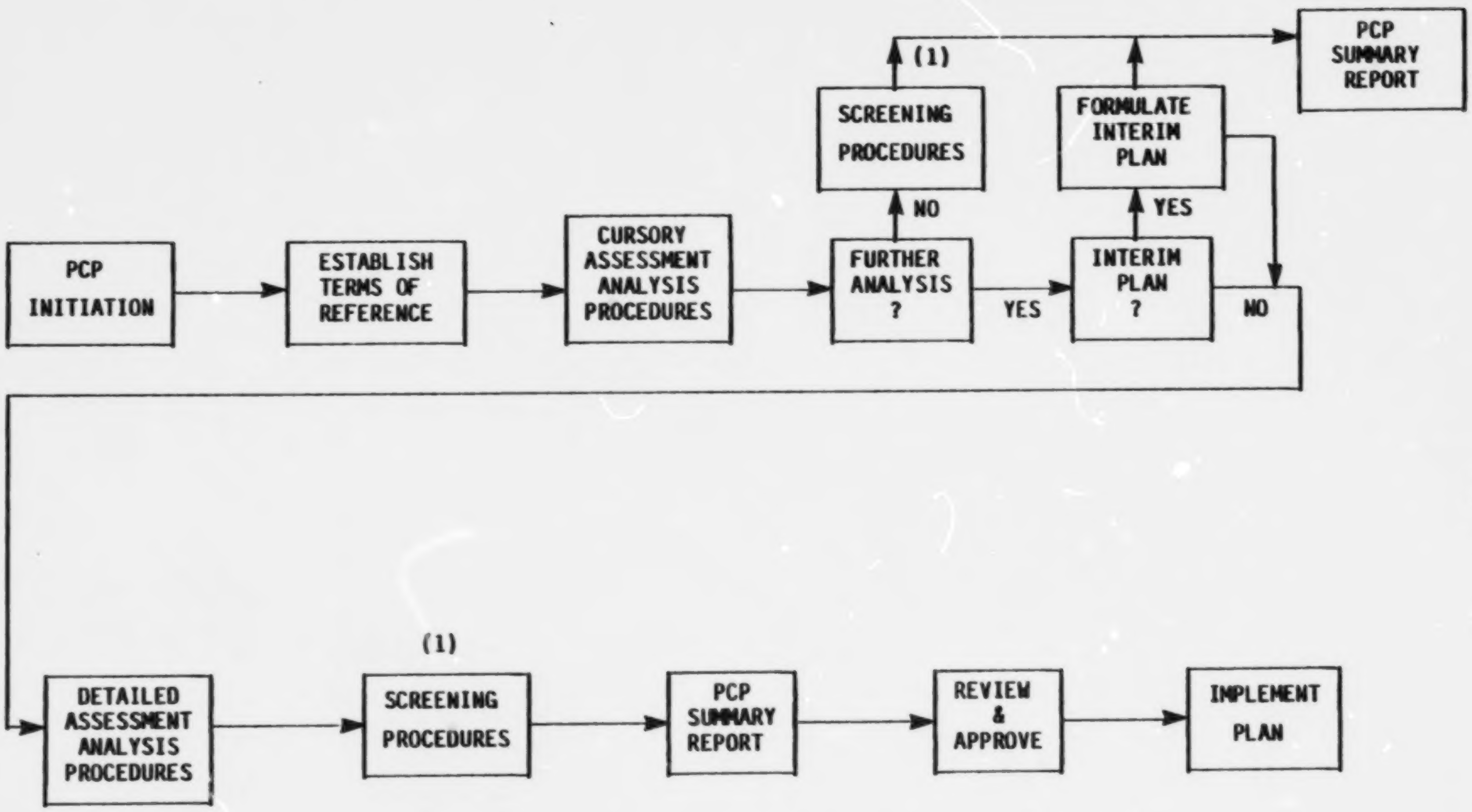
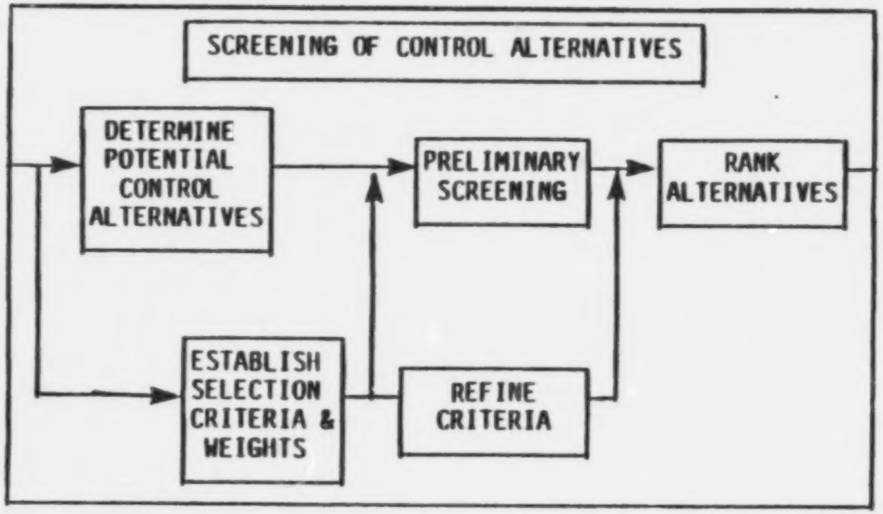

PCP INITIATION
ESTABLISH TERMS OF REFERENCE
CURSORY ASSESSMENT ANALYSIS PROCEDURES
FURTHER ANALYSIS ?
NO
SCREENING PROCEDURES
(1)
YES
INTERIM PLAN ?
YES
FORMULATE INTERIM PLAN
PCP SUMMARY REPORT
NO
DETAILED ASSESSMENT ANALYSIS PROCEDURES
(1)
SCREENING PROCEDURES
PCP SUMMARY REPORT
REVIEW & APPROVE
IMPLEMENT PLAN

FIGURE 1-2 - STEPS IN POLLUTION CONTROL PLAN PREPARATION

Note: (1) Screening procedures are actually component of cursory or detailed assessment procedures, but are shown here separately for purposes of illustration.


SCREENING OF CONTROL ALTERNATIVES
DETERMINE POTENTIAL CONTROL ALTERNATIVES
PRELIMINARY SCREENING
RANK ALTERNATIVES
ESTABLISH SELECTION CRITERIA & WEIGHTS
REFINE CRITERIA

Note (1): Details of Screening Procedure
Shown in Figure 1-2.

Once terms of reference are set and unless the need for more complex studies is initially identified, PCP preparation proceeds with a cursory assessment. Emphasis is placed on accomplishing the cursory assessment utilizing the simplest possible approach with as much reliance as possible on existing data sources.

Detailed assessment procedures may be required if the cursory assessment highlights the need for more sophisticated modelling of pollutant sources, control measures or water quality impacts. Detailed assessment may also be needed to develop additional data in support of analyses independent of the degree of sophistication.

It is important to point out that there is no distinct dividing line between the cursory and detailed assessment stages of a PCP. Every PCP will be different.

One further note is worthwhile in considering PCP development. Although the screening of alternatives is shown sequentially after the assessment phase (cursory or detailed) it is essential to identify the criteria used to screen alternative management plans as early in the PCP process as possible. The terms of reference should already give an indication of concerns with respect to specific water quality criteria (e.g. BOD_5, total-P) as well as any other relevant criteria (e.g. distribution of control costs among parties).

The output from PCP preparation will identify the management actions required from each of the parties. The final PCP summary report will be a public document giving the problem assessment, highlighting alternative management plans and presenting the preferred strategy. Technical analyses will be in the form of technical reports or of appendices to the summary report.

The purpose of the present report is to provide planning and technical guidelines and a synopsis of relevant reference material for the preparation of Pollution Control Plans. These guidelines will be of assistance to municipalities, regulatory agencies and consultants involved in the PCP process. The report is not intended to provide a detailed step-by-step procedure for PCP preparation (i.e. a manual), but rather an overview of the essential elements and key considerations of PCP formulation.

Chapters of this report deal with specific components of the PCP process as follows:

Chapter 2 "Basic Water Quality Concepts" deals with the fundamental cause-effect relationships of water quality management (i.e. nature and sources of pollutants, beneficial uses of water and the general types of water quality problems that may be encountered).

Chapter 3 "Relevant Legislation and Policies and Procedures" reviews the mandates and responsibilities for water management in Ontario, specifically as they relate to or interface with the PCP process.

Chapter 4 "Suggested Implementation Procedures and Terms of Reference" describes the factors that should be considered in assessing the need for a PCP and summarizes the key elements that are to be considered in developing the terms of reference for a PCP.

Chapter 5 "Cursory Assessment Procedures" outlines simplified procedures for quantifying water quality cause-effect relationships in a PCP area including:

- pollution source analysis,
- receiving water assessment,
- facilities analyses, and
- infiltration/inflow (I/I) assessment.

Chapter 6 "Detailed Assessment Procedures" identifies some of the areas which may require additional consideration and outlines some of the more advanced procedures for satisfying these requirements.

Chapter 7 "Pollution Control Alternatives" provides an overview of the control techniques available for point sources and non-point sources (stormwater and combined sewer overflows).

Chapter 8 "Pollution Control Plan Screening" summarizes procedures that can be utilized for screening and selecting a cost-effective, socially and environmentally acceptable PCP from a candidate set of control alternatives.

Chapter 9 "PCP Summary Report" provides suggested outlines for preparation of PCP reports.

Chapter 10 "PCP Case Study" gives in summary form the details of PCP-like study carried out in Cornwall, Ontario.

CHAPTER 2

BASIC WATER QUALITY CONCEPTS

2.1 General

The process of water quality management is complex, involving biological, physical and chemical interrelationships. Engineers or planners involved in the development of a PCP must be familiar with these interrelationships and also understand overall cause-effect reactions that occur in a receiving water when it is subjected to pollutant loadings. This Chapter summarizes basic information and references in the areas of (1) nature and sources of pollutants, (2) beneficial uses of water, (3) types of pollutant problems, and (4) receiving-water processes. General reference textbooks, manuals and review papers on the subjects of urban and/or non-urban pollution include EPA (1976), Whipple (1975), Lager and Smith (1974), Field et al (1981), and Wanielista (1978). Further background material, pertinent to Ontario is contained in several COA and PLUARG reports [(COA, 1980a), (Singer, 1979) and (Waller and Novak, 1981)].

2.2 Nature and Sources of Pollutants

Figure 2-1 illustrates the potential pathways of water and pollutant movement within a PCP planning area. For definition of the terms introduced in Figure 2-1 and elsewhere in this report, refer to the glossary in Appendix A. Within a specific planning area, pollutants can have natural, domestic, atmospheric, industrial or non-urban origins and can be delivered to the receiving water as storm sewer runoff, combined sewer overflows, wastewater treatment plant effluents, treatment plant bypasses, industrial treatment plant effluents or non-urban diffuse sources. Further detail on the urban interrelationships is provided in "The Manual of Practice for Urban Drainage" (COA, 1980a). Selected characteristics for typical pollutant sources for Ontario are summarized in Table 2-1. Areal loadings of various types of land use are also summarized in Table 2-1. These data, when used in conjunction with land use information for a specific PCP, can assist the planner in establishing relative magnitudes of various pollutant sources.

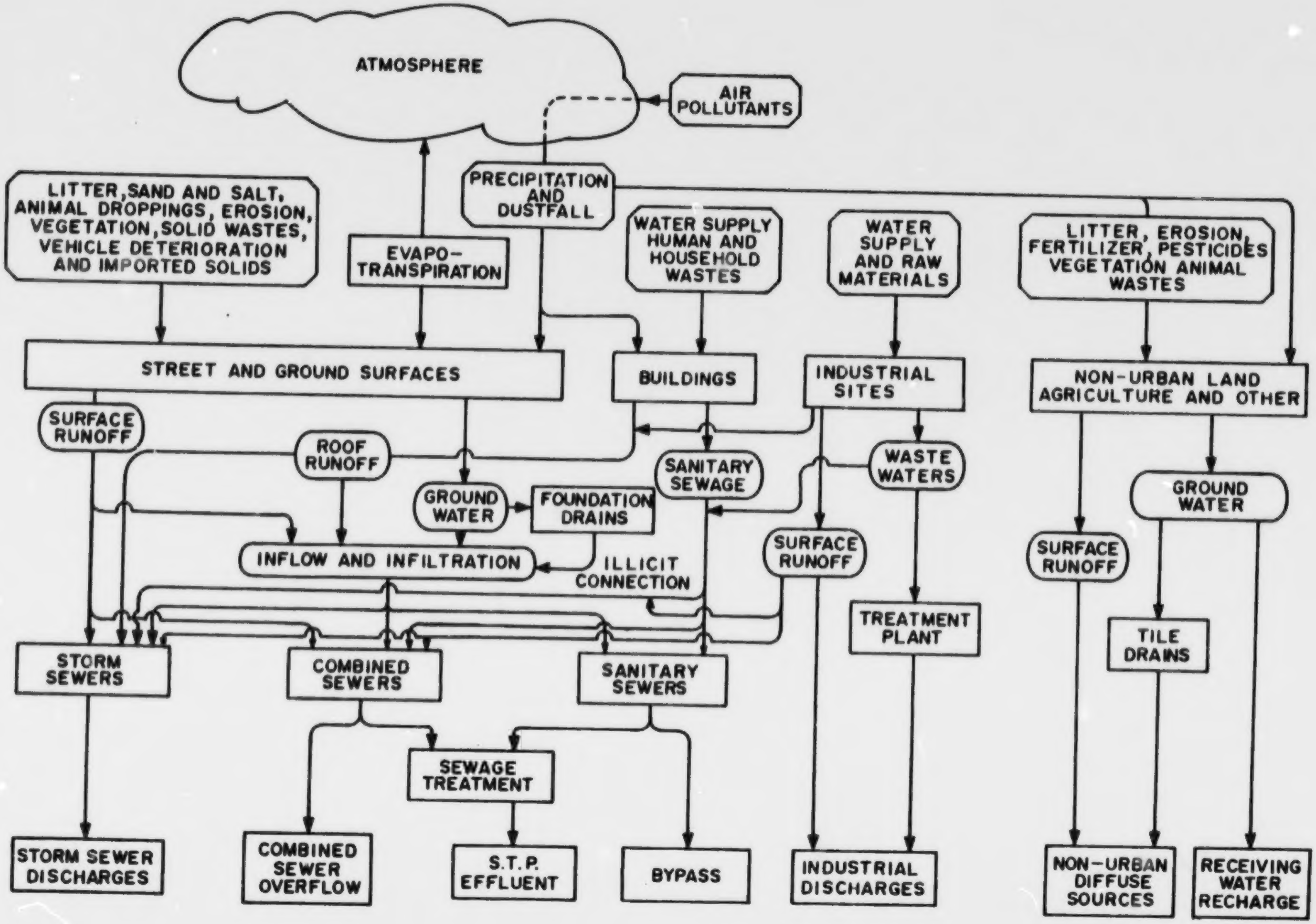

ATMOSPHERE
AIR POLLUTANTS
PRECIPITATION AND DUSTFALL
LITTER, SAND AND SALT, ANIMAL DROPPINGS, EROSION, VEGETATION, SOLID WASTES, VEHICLE DETERIORATION AND IMPORTED SOLIDS
EVAPO-TRANSPIRATION
WATER SUPPLY HUMAN AND HOUSEHOLD WASTES
WATER SUPPLY AND RAW MATERIALS
LITTER, EROSION, FERTILIZER, PESTICIDES VEGETATION ANIMAL WASTES
STREET AND GROUND SURFACES
BUILDINGS
INDUSTRIAL SITES
NON-URBAN LAND AGRICULTURE AND OTHER
SURFACE RUNOFF
ROOF RUNOFF
GROUND WATER
FOUNDATION DRAINS
SANITARY SEWAGE
WASTE WATERS
GROUND WATER
INFLOW AND INFILTRATION
ILLICIT CONNECTION
SURFACE RUNOFF
SURFACE RUNOFF
TREATMENT PLANT
TILE DRAINS
STORM SEWERS
COMBINED SEWERS
SANITARY SEWERS
SEWAGE TREATMENT
STORM SEWER DISCHARGES
COMBINED SEWER OVERFLOW
S.T.P. EFFLUENT
BYPASS
INDUSTRIAL DISCHARGES
NON-URBAN DIFFUSE SOURCES
RECEIVING WATER RECHARGE

FIGURE 2-1 — SOURCES AND MOVEMENT OF POLLUTANTS IN A PCP PLANNING AREA (MODIFIED FROM COA 1980 a)

TABLE 2-1. CHARACTERISTICS OF POTENTIAL POLLUTANT SOURCES

(a) CONCENTRATIONS

SOURCE	BOD (mg/L)	SS (mg/L)	TOTAL N (mg/L)	TOTAL P (mg/L)	TOTAL COLIFORMS (#/100 mL)	FECAL COLIFORMS (#/100 mL)
Raw Sewage[a]	165	225	30	6.5	10^8	10^7
Treatment By-Pass[a]	119	280	25(TKN)	4.5	-	
- Primary	50	50	22	1.0	10^7	10^6
- Secondary	17	23	18	1.0	10^4	10^3
Combined Sewer[a] Overflow	41	190	8.3	1.4	10^7	10^6
Urban Surface[a] Runoff	14	170	3.5	0.35	2×10^4	5×10^3
Non-Urban Runoff	(See Areal Loading Data)					
Industrial	(Variable Dependent on Industrial Processes and Manufactured Products)					

(b) AREAL LOADINGS (kg/ha/year)

LAND USE	BOD_5	SS	TKN	NO_3-N	TOTAL P
Urban - Commercial[b]	43	825	11.0	-	0.18
Industrial[b]	42	1082	14.0	-	0.92
Residential[b]	33	619	5.0	-	0.42
Rural General[c]	18	569	11.7	7.70	0.90
Wooded/Idle/Perennial Cover[c]	5	40.7	5.15	3.30	0.08
Combined Sewer Overflow	240	645	60	-	9.7

a (COA, 1980a)
b Waller and Novak (1981)
c Wanielista (1978)

2.3 Beneficial Uses of Water

The discharge of pollutants to lakes and streams can result in degradation of water quality, which can in turn interfere with or impair the beneficial uses of the water. During the inventory stage of the PCP, it is desirable to establish (1) the beneficial uses for the subject water resource, (2) any potential or existing conflicts of use, and if possible (3) prioritization of uses (i.e. What uses are highest and in the best interests of the municipality?).

The main beneficial uses of water in Ontario as set out in "Water Management Goals, Policies, Objectives And Implementation Procedures", MOE, "Blue Book" (1978) are:

(a) drinking water supply,
(b) swimming and bathing,
(c) preservation of habitat for aquatic life
(d) agricultural - general,
 - livestock watering,
 - irrigation,
(e) industrial - product water,
 - cooling water.

Other potential uses of water include fire protection, navigation, wildlife preservation and power generation. For further detail on beneficial uses refer to MOE (1984) and to the Ontario Drinking Water Objectives MOE (1983).

2.4 Water Quality Problems and Indicators

Water quality problems in natural water bodies can generally be classified into four broad categories: namely, public health risks, eutrophication (nutrient enrichment), dissolved oxygen depletion and others such as thermal pollution or sediment deposition. The main classes and examples of specific water quality indicators associated with each are summarized in Table 2-2.

It is important to identify the types of water quality problems that exist in a PCP area at an early stage of the analysis. Furthermore, the key water quality parameters (indicators) which best document the problems

TABLE 2-2. MAJOR CATEGORIES OF WATER QUALITY PROBLEMS AND ASSOCIATED WATER QUALITY INDICATORS

PROBLEM CATEGORY	GENERAL POLLUTANT CLASSES	EXAMPLE POLLUTANTS OR WATER QUALITY INDICATORS
Public Health Risks	Bacteria and viruses	Total and fecal coliforms Specific pathogens
	Hazardous Substances (Zero Tolerance)	PCB's, PBB's, DDT, Mercury, Mirex
	Hazardous Substances (Defined or Undefined Tolerance Limits)	Heavy metals, pesticides, various organic compounds (1)
Eutrophication	Nutrients	Nitrogen and phosphorus (primarily inorganic forms)
Dissolved Oxygen Depletion	Oxygen demanding materials	Biochemical oxygen demand (BOD) Chemical oxygen demand (COD) Organic nitrogen and ammonia
Other	Sedimentation	Suspended solids, turbidity and settleable solids
	Thermal (Waste heat) discharges	Temperature
	Nuisance (Aesthetic) materials	Turbidity, colour, floatables, odour
	Chemical materials	Dissolved solids (1)

Notes: (1) See MOE "Blue Book" (MOE, 1984) and Ontario Drinking Water Objectives (MOE, 1983) and Table 2-3.

should also be identified. These water quality indicators will be used throughout the process to quantify the nature and magnitude of the problem, and during the screening of alternatives phase, to determine the response of the water resource to specific control alternatives.

In general, numerical values for a specific water quality indicator(s) usually frame the goal or objective for water quality management (e.g. maintenance of a minimum dissolved oxygen of 5.0 mg/L at all times to provide suitable habitat for sport fishery). A composite listing of water quality indicators for which there are Ontario criteria or objectives are presented in Table 2-3. The listing includes the Provincial Water Quality Objectives for ambient water MOE (1984), which have been promulgated for the most part, on the basis of aquatic protection. The Ontario Drinking Water Objectives MOE (1983) are included in the Table for reference purposes as are the criteria for agricultural water use including irrigation and livestock watering. It should be noted that the Drinking Water Objectives refer to treated water at point of use. Reference should be made to the original documents for further detail on specific objectives.

2.4.1 Public Health Risks

Public health risks (hazards) generally result from (1) bacteria or viruses, or (2) hazardous substances. The Ontario ambient water quality objectives for protection of swimming, bathing and other recreational activities involving immersion of the user are based mainly on bacterial or viral considerations. Specifically, the water should not cause disease or infection in the human user. MOE (1984) defines a potential health hazard as a situation where there is a high risk of contracting a disease or infection from the use of the water and immediate corrective action is required. Water quality impairment is defined as a situation where there is some risk of disease from the use of the water, but a less restrictive course of action (e.g. maintain surveillance) can be followed.

Bacterial counts are commonly utilized to evaluate the safety of bathing waters with total coliform and fecal coliform bacteria being most commonly monitored. Although coliforms are not normally regarded as pathogenic, their presence in water indicates the potential presence of scarce and much more difficult to isolate pathogenic organisms.

TABLE 2-3. COMPOSITE OF WATER QUALITY OBJECTIVES/CRITERIA FOR ONTARIO

WATER QUALITY PARAMETER	PROVINCIAL WATER QUALITY OBJECTIVES	DRINKING (2) WATER OBJECTIVES	IRRIGATION(1) WATER OBJECTIVES	LIVESTOCK WATERING OBJECTIVES	COMMENTS
INORGANIC AND OTHER PARAMETERS					
Alkalinity & pH	*				* Should not be decreased by more than 25% natural concentration; pH range 6.5-8.5
Ammonia	0.02 mg/L				- Un-ionized Ammonia
Chloride		250 mg/L			- MDC
Chlorine	0.002 mg/L				- Total Residual Chlorine
Colour		5 TCU			- MDC; TCU True Colour Units
Cyanide	0.005 mg/L	0.2 mg/L			- Free Cyanide
Dissolved Gases	*				* Less than 110% of Saturation
Dissolved Oxygen	*				* Temperature and biota type dependent; see MOE, 1984
Fluoride		2.4 mg/L	1.0 mg/L	2.0 mg/L	
Hydrogen Sulphide	0.002 mg/L	inoffensive			- Undissociated
Methane		3 L/M^3			- MDC
Nitrate		10 mg/L		* 100 mg/L	- As N; * NO_3 + NO_2
Nitrite		1.0 mg/L		10 mg/L	- As N
Nitrilotriacetic Acid		0.05 mg/L			
Odour		inoffensive			- MDC
Oil and Grease					- See MOE, 1984
Organic Nitrogen		0.15 mg/L			- MDC; TKN-NH_3
Phenols	0.001 mg/L	* 0.002 mg/L			* MDC
Sulphate		500 mg/L			- MDC
Taste		inoffensive			
Temperature	*	15°C			* See MOE, 1984
Total Dissolved Solids		500 mg/L *			* MDC
Total Organic Carbon		5.0			- MDC
Turbidity	*	1 FTU			* See MOE, 1984

TABLE 2-3 (CONT'D). COMPOSITE OF WATER QUALITY OBJECTIVES/CRITERIA FOR ONTARIO

WATER QUALITY PARAMETER	PROVINCIAL WATER QUALITY OBJECTIVES	DRINKING (2) WATER OBJECTIVES	IRRIGATION(1) WATER OBJECTIVES	LIVESTOCK WATERING OBJECTIVES	COMMENTS
HEAVY METALS AND OTHER PARAMETERS (3)					
Aluminum	--	--	5.0 mg/L	5.0 mg/L	
Arsenic	100 ug/L	0.05 mg/L	0.10 mg/L	0.20 mg/L	
Barium	--	1.0 mg/L	--	--	
Beryllium	11 ug/L*	--	0.10 mg/L	--	* For hardness <75 mg/L as $CaCO_3$
	1100 ug/L**	--			** For hardness >75 mg/L as $CaCO_3$
Boron	--	5.0 mg/L	0.75 mg/L	5.0 mg/L	
Cadmium	0.2 ug/L	0.005 mg/L	0.01 mg/L	0.05 mg/L	
Chromium	100 ug/L	0.05 mg/L	0.10 mg/L	1.0 mg/L	
Cobalt	--	--	0.05 mg/L	1.0 mg/L	
Copper	5 ug/L	*1.0 mg/L	0.20 mg/L	0.5 mg/L	* MDC
Iron	300 ug/L	*0.3 mg/L	5.0 mg/L	--	* MDC
Lead	*	0.05 mg/L	5.0 mg/L	0.1 mg/L	* See MOE, 1984
Lithium	--	--	2.5 mg/L	--	
Manganese	--	*0.05 mg/L	0.20 mg/L	--	* MDC
Mercury	*0.2 ug/L	0.001 mg/L	--	0.01 mg/L	* Filtered sample; zero tolerance
Molybdenum	--	--	0.01 mg/L	--	
Nickel	25 ug/L	--	0.2 mg/L	1.0 mg/L	
Selenium	100 ug/L	0.01 mg/L	0.02 mg/L	0.05 mg/L	
Silver	0.1 ug/L	0.05 mg/L	--	--	
Uranium	--	*0.02 mg/L	--	--	* Interim MAC
Vanadium	--	--	0.1 mg/L	0.1 mg/L	
Zinc	30 ug/L	*5.0 mg/L	2.0 mg/L	25 mg/L	* MDC
PESTICIDES (4)		(6)			
Aldrin/Dieldrin	0.001 ug/L	0.0007 mg/L	- (5)	0.001 mg/L	
Carbaryl	-	0.07 mg/L	-	-	
Carbamate and Organo-Phosphates	-	-	-	0.1 mg/L	
Chlordane	0.06 ug/L	0.007 mg/L	-	0.003 mg/L	
Chlorphyrifos	0.001 ug/L				

TABLE 2-3 (CONT'D). COMPOSITE OF WATER QUALITY OBJECTIVES/CRITERIA FOR ONTARIO

WATER QUALITY PARAMETER	PROVINCIAL WATER QUALITY OBJECTIVES	DRINKING (2) WATER OBJECTIVES	IRRIGATION(1) WATER OBJECTIVES	LIVESTOCK WATERING OBJECTIVES	COMMENTS
PESTICIDES (4)					
DDT	* 0.003 ug/L	0.03 mg/L	-	0.05 mg/L	* Zero Tolerance Limit
Dicamba	200 ug/L	-	-	-	
Diquat	0.5 ug/L	-	-	-	
Diuron	1.6 ug/L	-	-	-	
Dalapon	110 ug/L	-	-	-	
Diazinon	0.08 ug/L	0.014 mg/L	-	-	
Endosulphan	0.003 ug/L	-	-	-	
Endrin	0.002 ug/L	0.0002 mg/L	-	0.0005 mg/L	
Fenthion	0.006 ug/L	-	-	-	
Guthion	0.005 ug/L	-	-	-	
Heptachlor and Heptachlor Epoxide	0.001 ug/L	0.003 mg/L	-	0.0001 mg/L	
Lindane	0.01 ug/L	0.004 mg/L	-	0.005 mg/L	
Malathion	0.1 ug/L	-	-	-	
Methoxychlor	0.04 ug/L	0.1 mg/L	-	1.0 mg/L	
Methyl Parathion	-	0.007 mg/L	-	-	
Parathion	0.008 ug/L	0.035 mg/L	-	-	
Pyrethrum	0.01 ug/L	-	-	-	
Simazine	10 ug/L	-	-	-	
Toxaphene	0.008 ug/L	0.005 mg/L	-	0.005 mg/L	
2,4 D	4.0 ug/L	0.1 mg/L	-	-	
2,4,5 TP	-	0.01 mg/L	-	0.1 mg/L	
INDUSTRIAL AND OTHER ORGANICS					
Dibutyl Phthalate	4.0 ug/L	-	-	-	
Diethyl Hexyl Phthalate	0.6 ug/L	-	-	-	
Other Phthalates	0.2 ug/L	-	-	-	
Dechlorane (Mirex)	* 0.001 ug/L	-	-	-	* Zero Tolerance Limit

TABLE 2-3 (CONT'D). COMPOSITE OF WATER QUALITY OBJECTIVES/CRITERIA FOR ONTARIO

WATER QUALITY PARAMETER	PROVINCIAL WATER QUALITY OBJECTIVES	DRINKING (2) WATER OBJECTIVES	IRRIGATION(1) WATER OBJECTIVES	LIVESTOCK WATERING OBJECTIVES	COMMENTS
INDUSTRIAL AND OTHER ORGANICS					
Polychlorinated Biphenyls	* 0.001 ug/L	** 0.003 mg/L	-	-	* Zero Tolerance Limit; ** Interim MAC
Polybrominated Biphenyls	*				* Zero Tolerance Limit
Trihalomethanes	-	* 0.35 mg/L	-	-	* Chloroform + Bromodichloromethane + Chlorodibromomethane + bromoform
RADIONUCLIDES (7)	*				* See also MOE 1984
Cesium - 137	50 Bq/L	** 50 Bq/L	50 Bq/L	50 Bq/L	** Becquerels/Litre; See also MOE 1983
Iodine - 131	10 Bq/L	10 Bq/L	10 Bq/L	10 Bq/L	
Radium - 226	1 Bq/L	1 Bq/L	1 Bq/L	1 Bq/L	
Strontium - 90	10 Bq/L	10 Bq/L	10 Bq/L	10 Bq/L	
Tritium	40,000 Bq/L	40,000 Bq/L	40,000 Bq/L	40,000 Bq/L	
MICROBIOLOGICAL					
Total Coliforms	* 1000 org/dL	** 5 org/dL	1000 org/dL	-	* See also MOE 1984; ** See also MOE 1983
Fecal Coliforms	* 100 org/dL		100 org/dL	-	* See also MOE 1984
P. Aeruginosa		Not Detected in any Sample			
S. Aureus					
Fecal Streptococci					
Aeromonas Sp.		*			* See MOE 1983

Notes:
1) Criteria presented are for waters used continuously on all soil types. For other criteria see MOE 1984.
2) Concentrations presented are Maximum Acceptable Concentrations (MAC) unless otherwise specified. MAC is a term used for limits applied to substances above which there are known or suspected adverse health effects. In contrast, Maximum Desirable Concentrations (MDC) applies to limits on substances which, when present at concentrations above the limits are either aesthetically objectionable to an appreciable number of consumers or may interfere with good water quality control.
3) Specified for unfiltered samples unless otherwise noted.
4) Specified for unfiltered samples unless other wise noted.
5) Selected herbicides of the hormone type (e.g. 2,4-D) and triazine type (e.g. atrazine) should be below 0.5 ug/L to prevent damage to seedlings (see MOE 1978 for details).
6) When more than one pesticide is present, the total pesticides shall not exceed the sum of their MAC's or 0.1 mg/L, whichever is lesser.
7) If two or more radionuclides affecting the same organ or tissue are found to be present, the following relationship should be satisfied:

$$\frac{c_1}{C_1} + \frac{c_2}{C_2} \ldots\ldots \frac{c_i}{C_i} \leq 1$$

where $c_1, c_2, \ldots c_i$ = Observed Concentrations
$C_1, C_2, \ldots C_i$ = MAC's

A hazardous substance is defined (MOE, 1984) as a substance which (individually or in combination with other substances) can cause death, disease including cancer, behavioral abnormalities, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformities in organisms or their offspring. Obviously, this definition encompasses many of the substances listed in Table 2-3 and others not listed. Two classes of hazardous substances are considered by MOE (1984) in the context of ambient water quality protection:

(1) substances with zero tolerance (Table 2-3) in which any release should be completely eliminated, and

(2) substances with defined or at present undefined tolerance limits which may pose an adverse effect on health.

For further detail on health related aspects, the reader should refer to MOE, 1983 and 1984 and James and Evison (1979).

2.4.2 Toxicity Effects

Aquatic toxicity (lethal or chronic) effects, other than human health effects, in receiving waters can result from minute discharges of metals, pesticides and persistent organics. For example, refer to substances listed previously in Table 2-3. These substances may exhibit a subtle long-term effect in the receiving water by gradually accumulating in the receiving water sediments and/or biota. An example of this is shown in a comparison of the accumulation effect of organics and phosphorus, metals, chlorinated hydrocarbons and PCBs in sediments downstream of combined sewer overflows, (CSO) storm sewer outfalls and an unpolluted area (Figure 2-2). The data are from Tomlinson et al (1980) and are expressed in terms of a composite sediment enrichment index. Heavy metals such as lead and zinc tend to accumulate in algae, crayfish and rooted plants (e.g. Field and Turkeltaub (1981) report bioaccumulation factors of 100 to 500 times the water column concentrations).

Petroleum hydrocarbons can enter the receiving stream via urban discharges, with material generally originating from motor vehicles' activities (spills, leaks, disposal of lubricants and hydraulic fluids). Some of these hydrocarbons have been shown to be carcinogenic and mutagenic.

For further technical detail on toxicity effects, reference should be made to EPA (1966), Fitzsimons and Reinke (1977) and MOE (1984).

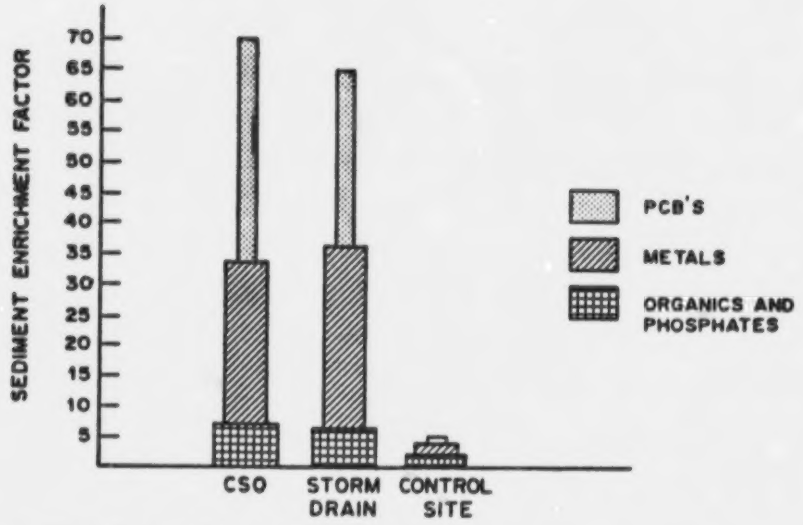


FIGURE 2-2 - EXAMPLE OF POLLUTANT ACCUMULATION IN SEDIMENTS DOWNSTREAM OF COMBINED SEWER OUTFALL AND STORM DRAIN (TOMLINSON, et al 1980)

2.4.3 Eutrophication

The OECD (1966) has provided the following broad definition of eutrophication - "Eutrophication is the nutrient enrichment of waters which results in an array of symptomatic changes among which the production of algae and other aquatic plants, the deterioration of fisheries, the deterioration of water quality changes are found objectionable and interfere with water use". Excessive nitrogen and/or phosphorous in combination with proper water temperature and sunlight conditions can result in disproportionate accumulations of aquatic plants, which in turn can lead to wide fluctuations of dissolved oxygen, taste and odour, and aesthetic problems.

Some of the common indicators of eutrophication in lakes and streams are summarized in Table 2-4.

TABLE 2-4. SYMPTOMS OF RECEIVING WATER EUTROPHICATION

Increase in nutrient levels
Increase in chlorophyll a levels
Increase in algal or rooted plant biomass
Wide dissolved oxygen fluctuations
Changes in species diversity
Decrease in water transparency
Presence of certain indicator species (e.g. coarse fish and blue-green algae)

In the PCP process, nutrient concentrations or loadings, chlorophyll a, plant biomass and or dissolved oxygen are some of the eutrophication indicators which may be utilized as management goals and for determining the effectiveness of control alternatives. For example, the management goals for a lake may be to maintain a chlorophyll a concentration of less than 25 ug/L and at least 4.0 mg/L of dissolved oxygen in the lake bottom waters at times.

For further background on eutrophication causes and effects, reference should be made to Vollenweider (1968), Loehr et al (1980) and NAS (1969).

2.4.4 Dissolved Oxygen Depletion

The quantity of dissolved oxygen (DO) in a receiving water provides an excellent overall measure of water quality. For example, non-polluted streams exhibit DO levels near atmospheric saturation and have healthy diverse biological communities. For areas of a water body downstream or adjacent to a wastewater (organic) point or non-point discharge, a zone of active decomposition will develop which will result in a reduction of oxygen below saturation or even to the state of complete depletion. The classical response of a stream to an organic wasteload is shown in Figure 2-3.

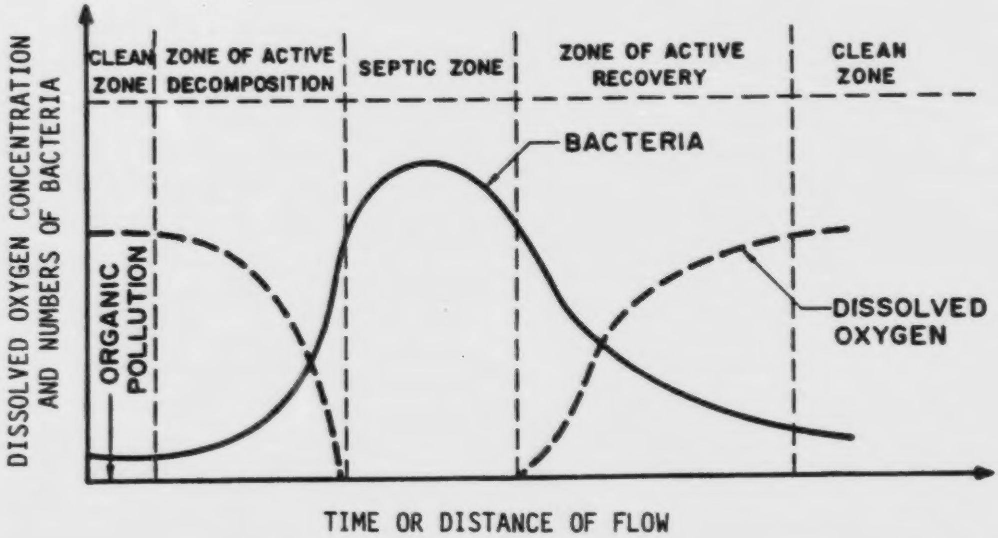


FIGURE 2-3 - OXYGEN SAG CURVE AND CORRESPONDING BACTERIA POPULATION IN POLLUTED STREAM

Sedimentation of the suspended solids fraction of a waste discharge may result in the accumulation of bottom deposits which will exert a benthal oxygen demand. Nutrient enriched or eutrophic waters with substantial algae or macrophyte populations will exhibit large fluctuations in DO, i.e. supersaturated conditions during daytime due to photosynthetic production of oxygen and depleted conditions during the nighttime due to respiration demands for oxygen. Extensive technical information is available on oxygen depletion effects, e.g. Thomann (1972), Hynes (1963), Klein (1966), Fair and Geyer (1954) and Nemorow (1971).

2.4.5 Sediment Effects

As pointed out in the previous section on oxygen depletion effects, organic solids from sewer discharges can accumulate on stream bottoms below outfalls, thereby exerting a benthic oxygen demand. In addition, sediment from combined sewer overflows, storm sewers and treatment plant discharges and from soil erosion and construction sites can cause turbidity problems, fill reservoirs and block navigational channels.

In some instances, deposited sediments can have direct and adverse effects on fish populations by spoiling spawning areas, fouling gills and smothering bottom organisms upon which the fish feed.

2.4.6 Salt Effects

Urban runoff may contain excessive salt levels, particularly winter or spring runoff from areas where road deicing with salt is practiced. Excessive salt levels can potentially impair receiving water quality for some industrial uses, palatability of water supply (e.g. dietary sodium effects) and change stratification characteristics of lakes. Further details on salt effects are provided by Scott (1976) and MOE (1975b).

2.4.7 Thermal Effects

Thermal pollution can be described as anything that substantially changes water temperature and adversely effects the water ecology and the life that depends on it. Most thermal discharges originate from electrical power generating plants; however, the petroleum, chemical, steel, pulp and paper and other industries may also discharge thermal effluents. Thermal discharges can cause stratified flow to occur in receiving streams, or changes in the mixing patterns of lakes or reservoirs due to water density differences. Receiving water temperature changes, may in turn, result in reduced waste assimilation capacity and changes in the stream biota (bacteria, algal and rooted plants, zooplankton and fish). For further detail on engineering and biological aspects of thermal pollution, reference should be made to Gerber et al (1967), Parker and Krenkel (1969) and Krenkel and Parker (1969).

2.5 Receiving Water Processes

The response of lakes and streams to pollutant sources is governed by a myriad of physical, chemical and biological factors. It is beyond the scope of this report to go into extensive detail on this aspect (some further information is provided in Chapters 5 and 6); consequently, only a brief summary is provided.

The interrelationships between physical, chemical and biological factors are complex and vary from one receiving water to another with key parameters selected for consideration in any given situation being determined by the nature of the pollutant, its behaviour in the aquatic environment and the objectives of the water quality assessment. Some of the important processes are listed below:

Physical:

- convection, diffusion, evaporation, adsorption, flocculation, sedimentation, scour, gas transfer, thermal phenomena, light attenuation.

Chemical:

- hydrolysis, ionization, chemical transformation, reaction kinetics.

Biological:

- growth and death of viruses, bacteria, molds, fungi, algae, fish and other aquatic organisms; photosynthesis and respiration.

Further detail on receiving water processes can be obtained by reference to MOE (1980a), Chen (1970), DiToro et al (1970), Parker (1968), Thoman (1972) and others.

2.6 Dissolved Oxygen Factors

The dissolved oxygen (DO) regime of a receiving water is generally an indicator of its overall water quality. Consequently, DO is the parameter of prime interest in many water quality assessments. Factors that influence DO include climate and stream geomorphology, quantity and variation of flow, sunlight, temperature, basin vegetation, nutrients, pH, toxicity of specific compounds and other factors. Sources of dissolved oxygen include natural reaeration, photosynthesis, tributary in-flows, artificial aeration and other processes such as denitrification and sulphate reduction. Sinks or demands for oxygen include biochemical oxidation of carbonaceous and nitrogenous organic substances, algal respiration, oxidation of inorganic chemicals and benthic (or bottom) oxygen requirements. Further detail on these processes is available from MOE (1980), Warren (1971), Gordon et al (1968) and EPA (1976).

CHAPTER 3

RELEVANT LEGISLATION, POLICIES AND PROCEDURES

3.1 General

An excellent review of the mandates and responsibilities for water management in Ontario has been compiled by Yu (1980) and should be consulted for detail on specific legislation. Additional sources of information include Castrilli (1977), Mitchell (1975), Salbach and Dennis (1979) and Estrin and Swaigen (1978).

A summary list of statutes and policies which are/may be pertinent to the PCP process is presented in Table 3-1. Some of the more significant acts, policies and in addition, relevant MOE procedures are discussed individually in the following sections. Specific or potential interrelationships between the various acts, policies or procedures and the PCP process are pointed out.

3.2 Environmental Protection Act

The Environmental Protection Act provides for the regulation, among other things, of waste management and sewage systems. The Act requires that a certificate of approval be obtained to build or modify a system or process (e.g. treatment plant) that may emit a pollutant. A broad ranging provision of the Act is that it, conceptually, allows no one to release a contaminant into the natural environment which will harm man, the natural environment or any living thing.

The Act provides for a system of enforcement including orders and offence creating provisions. Approvals are given under the Act by Directors (with certain powers) and an Environmental Appeals Boards. The Director has varying powers of decision making depending on the relevant section of the Act. Where he is required or permitted to hold a hearing, he may require the Environmental Assessment Board to hold the hearing. (See Environmental Assessment Act section following.)

The Environmental Assessment Board reports to the Director and the Director makes the final decision on the project. The Act also provides for an Environmental Appeal Board.

TABLE 3-1. SUMMARY OF STATUTES AND POLICIES RELEVANT TO THE PCP PROCESS

(A) ACTS	RESPONSIBLE AGENCY	COMMENTS
(a) Federal Fisheries Act (RSC. 1970 c.FC 14 as amended)	Department of Fisheries & Oceans & Dept. of Environment. MNR in Ontario	Prohibits the discharge of substances deterious to fish. Effluent regulations developed for five industrial categories.
Canada Water Act (RSC. 1969-70 C.5 as amended)	Dept. of Environment	Part III of Act provides for phosphate controls of laundry detergents.
Canada Shipping Act (RSC. 1970 C.5-9, as amended)	Dept. of Environment Dept. of Transport	Prohibits discharge of pollutants by shipping sources (ships, and cargo transfer operations).
Navigable Waters Protection Act (RSC. 1968-69, C.N.-19)	Dept. of Transport	Prohibits deposit of any substances in a navigable waterway includes erection and placement of works.
Migratory Birds Conservation Act (RSC. 1970,C.M.-12)	Environment Canada Wildlife Service	Prohibits deposit of oil, oil wastes or any other substance harmful to migratory birds in any waters or areas frequented by birds.
Boundary Waters Treaty Act	International Joint Commission (IJC)	Governs pollution in the boundary waters of Canada and U.S.A. (e.g. Greak Lakes).
Pest Control Products Act (RSC. 1970 C.P.-10 as amended)	Dept. of Agriculture (Pest Control Products Div.)	Prior to registration, information on the fish and water quality effects is required. Registration may be revoked.
Fertilizers Act (RSC. 1970 C.F.-9)	Dept. of Agriculture (Plant Products Div.)	Fertilizer may not contain any materials that may be harmful to public health or the environment.
(b) Provincial Ontario Water Resources Act (RSO 1980 Ch.361 as amended)	Ministry of Environment	Provision for approval of municipal and industrial sewage works. Approvals governed by MOE (1978). See policies in text.
Environmental Protection Act (RSO 1971, Ch.86 as amended 1972 & 73)	Ministry of Environment	Provides for the protection and conservation of the natural environment including surface and groundwater. Governs certificates of approval for disposal sites and systems, control, stop and restraint orders. Appeal to Environmental Appeal Board possible.
Pesticides Act (RSO 1973 Ch.25 as amended)	Ministry of Environment	Control use of pest control chemicals. Permits required for certain pesticides. Prohibits equipment cleaning in watercourse. Governs container disposal.
Ontario Fisheries Act (1954 amended 1975)	Ministry Of Natural Resources	Broadly covers all aspects of fishing in Ontario (seasons, quotas, methods, etc.).
Lakes & Rivers Improvement Act (RSO 1970 Ch.233 as amended)	Ministry of Natural Resources	Provides for the use of waters of the lakes and rivers of Ontario and regulates improvements. Provides for the use, management and perpetuation of fish and wildlife and preservation of natural water body amenities.
Municipal Act (RSO 1970 Ch.284 as amended)	Ministry of Municipal Affairs and Housing	Empowers municipalities to enact bylaws prohibiting and regulating the discharge of gaseous, liquid and solid matter into drainage or sewer works. Provides authority for compulsory sewer hookups. Governs long-term financing for sewer systems.
Conservation Authorities Act (RSO 1970 Ch.78 as amended)	Report to the Province through Ministry of Natural Resources	Provides designated conservation authorities with broad based water quality management responsibilities including maintenance of flow for dilution of effluents and water supply. Have authority to construct flood control works.

TABLE 3-1 (CONT'D). SUMMARY OF STATUTES AND POLICIES RELEVANT TO THE PCP PROCESS

(A) ACTS	RESPONSIBLE AGENCY	COMMENTS
Environmental Assessment Act (RSO 1975)	Ministry of Environment	Requires project proponent to undertake comprehensive studies on the environmental social, economic and physical impacts of the undertaking and its alternatives.
The Planning Act (RSO 1970 Ch.349 as amended)	Ministry of Housing	Governs approval of official and subdivision plans. Subdivision plans must take into account health and conservation of natural resources.
Pits & Quarries Act (RSO 1971 Ch.96 Ch.390 as amended)	Ministry of Natural Resources	Governs effects of mining or quarrying operations or drainage on water table or surface drainage. Has licencing provisions.
The Consolidated Hearings Act, 1981 (Bill 89)	Ministry of Intergovernmental Affairs	The Act provides for a consolidated hearing for an for an undertaking which requires hearings under one of more Acts such as Water Resources Act, Environmental Protection Act, Municipal Act, etc.
Public Utilities Act (RSO 1970 Ch.390 as amended)	Ministry of Intergovernmental Affairs	Gives municipalities authority to divert water from lakes or streams as may be deemed necessary for waterworks or preserving the purity of a water supply.
Local Improvement Act (RSO 1970 Ch.255 as amended)	Ministry of Intergovernmental Affairs	Sets out procedures for undertaking local improvements such as water supply systems, breakwaters and shore protection works.
Drainage Act (RSO 1975, Ch.39)	Ministry of Agriculture & Food	Sets out financial arrangements for construction of municipal drains.
Tile Drainage Act (RSO 1971,Ch.37 as amended)	Ministry of Agriculture & Food	Provides for assistance in the construc tion of on-farm tile drainage.
Beds of Navigable Waters (RSO 1970,Ch.41)	Ministry of Natural Resources	Non-patented lands which border on navigable bodies of water and the bed of a navigable body of water or stream are Crown lands. Authorization from MNR is required for any activity in crown-controlled water areas.
(B) POLICIES	RESPONSIBLE AGENCY	COMMENTS
Policy to govern the level of treatment required at Municipal & Private Sewage Treatment works discharging to surface waters (Policy 08-01, 08-06)	Ministry of Environment	Policy which governs the level of treatment required at municipal and private sewage treatment works discharging to surface waters, falls under Water Resources Act.
Policy to govern the Provision and Operation of Phosphorus Removal facilities at Municipal and Private Sewage Treatment Works (08-04)	Ministry of Environment	Requires the installation of phosphorus removal facilities at municipal and institutional wastewater treatment plants located in the Great Lakes, parts of the Ottawa River system, and inland recreational areas.
Minimum Requirements for Municipal and Private Combined Sewer Systems (draft)	Ministry of Environment	Describes the minimum requirements for the hydraulic capacity, operation and maintenance and management of combined sewer systems. Legislative authority provided by Water Resources Act.
Conditions requiring Initiation of Expansion and/or Upgrading for Municipal and Private Sewage Treatment Works (draft)	Ministry of Environment	Describes the conditions requiring initiation of expansion and/or upgrading for municipal and private sewage treatment works.
Strategic Planning for Ontario Fisheries (SPOF)	Ministry of Natural Resources	Provides for maintenance of fish communities in the North and rehabilitation in the South.

3.3 Ontario Water Resources Act

The Ontario Water Resources Act came into being in the 1950's and has been amended several times. Fundamentally, the Act regulates the collection, treatment and disposal of sewage and the use of water. The thrust of the Act is to make illegal any activity that may impair the quality of water in Ontario. In this sense, the Act seeks to preserve the purity of and prevent the pollution of natural waters.

The Act is enforceable by way of several offence creating sections. Decision making processes under the Act are accomplished by the Minister, the Director, the Environmental Assessment Board, the Environmental Appeal Board and the Ontario Municipal Board. As with the Environmental Protection Act, a Director has varying powers of decision making depending on the relevant section of the Act. Where he is required or permitted to hold a hearing, he may require the Environmental Assessment Board to do so. If a Director makes a decision, it may generally be appealed to the Environmental Appeal Board.

The Environmental Assessment Board holds hearings pursuant to instructions from a Director and reports to the Director. The Environmental Assessment Board has no decision making power, whereas the Environmental Appeal Board does. The Minister may hear appeals on decisions of the Environmental Appeal Board.

3.4 Provincial Water Quality Objectives (PWQO)

Some of the water quality criteria of the MOE "Blue Book" (1984) have been summarized in Chapter 2. The "Blue Book" is the main document for providing objectives for the Ontario Water Resources Act and the Environmental Protection Act and provides goal statements for the management of surface waters and groundwaters. The "Blue Book" is in essence, a translation of these Acts and provides the foundation for water quality management in Ontario. For each goal, a set of policies have been adopted to achieve that goal. For surface water management, the goal has been stated as: "To ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life." More simply the goal is to have fishable and swimmable waters with the assumption being that if waters meet these criteria, they will be suitable for most other beneficial uses.

The surface water management policies stated are:

(1) Maintenance of water quality in areas which have water quality better than the Provincial water quality objectives (i.e. protection of non-degraded areas).

(2) Waters which presently do not meet the Provincial water quality objectives are not to be degraded further and all practical measures shall be taken to upgrade the water quality to meet objectives.

(3) Effluent requirements will be established on a case-by-case basis. The characteristics of the receiving water, as well as Federal and Provincial effluent regulations, will be considered in setting such requirements. These effluent requirements will be incorporated into Certificates of Approval (Ontario Water Resources Act) and will specify both waste loadings and concentrations.

(4) Special preventative measures are required to deal with the release of known or potentially hazardous substances.

(5) Provision for mixing zones in receiving water areas contiguous to point source discharges. Mixing zones are to be established on a case-by-case basis.

Exemptions from Policy 2 are possible, if it can be demonstrated that natural background water quality or irreversible man-induced conditions prevent the attainment of the Objectives. In addition, lack of suitable treatment technology or substantial and widespread economic and social impacts can be used to gain exemption. These exemptions would usually be considered as part of public hearings under the Environmental Protection Act or the Ontario Water Resources Act.

The "Blue Book" addresses other pollutant sources in addition to treatment plant effluents. It states that, in establishing effluent requirements for point sources, consideration must be given to the effects of contaminant inputs from non-point sources on receiving water quality. The PCP process provides a workable mechanism for putting the policies of the "Blue Book" into practice.

3.5 Environmental Assessment Act

The Environmental Assessment Act was passed in 1975 and provides the statutory basis for the assessment of the potential effects on the environment of a proposal and its alternatives. The Act has wide-spread ramifications of a preventative nature and will definitely interrelate with the PCP process, particularly at the alternative and decision stages and during public participation components. The purpose of the Act is to assure that a decision is made on each project on a cost-effective and environmentally sound basis (i.e. similar considerations as the alternative analyses step of the PCP process in Figure 1-2.)

The Act requires the anticipation of problems that may be generated as the result of a project. The Environmental Assessment Act requires that a project which is subject to the Act must be brought into compliance with the Act, through the acceptance of an Environmental Assessment and Approval issued to proceed or through the issuance of an exemption by regulation or order, before any other provincial or municipal approvals for the project may be issued.

PCP objectives and procedures closely parallel those of EA. Since both processes are concerned with systematic decision-making. Evaluation of alternatives and their impact upon a number of monetary and non-monetary factors is central to both; as well as the requirement for meaningful public consultation. As noted, EA will take precedence over the PCP. The PCP proponent(s) must therefore ensure that the EA requirements associated with the projects likely to result from PCP preparation will be met. Reference should be made to the Municipal Engineers Association report (MEA, 1982) documenting Class EA requirements and procedures and to the Ministry's Environmental Assessment Branch.

Projects fall into various categories of application of the Environmental Assessment Act. The types of project that could result from a PCP, and would be subject to Class Environmental Assessment procedures are presented in Table 3-2. In addition, some projects may be subject to the requirements of full Environmental Assessment procedures. This will occur only rarely and hence is not discussed further. The Ministry's Environmental Assessment Branch should be contacted for information regarding requirements and procedures for a full EA.

TABLE 3-2. PCP PROJECTS SUBJECT TO CLASS EA CATEGORIES

SCHEDULE A: Activities Proposed for Total Exemption

1. Normal and emergency operations activities. Such activities might include, but are not limited to the following:
   - modify, repair, reconstruct existing facilities to provide operational, maintenance or other improvements such as: reducing odour; insulating buildings to reduce noise levels and conserve energy; landscaping.
   - on-going maintenance activities.
   - normal operation of sewage treatment plants.
   - installation of new service connections from existing sewers.
   - maintenance and/or minor improvements to grounds and structures.
   - addition of minor buildings, sheds and storage areas.
   - repairs, cleaning, renovations or replacement of sewage treatment facilities, pumping plant equipment, or outfalls.
   - cleaning and/or relining existing collection system.
   - repairs and renovations to existing collection system and/or appurtenances.
   - increasing pumping station capacity by adding or replacing equipment and appurtenances where new equipment is located within an existing shell or housing structure.
   - installation or replacement of standby power equipment where new equipment is located within an existing shell or housing structure.

2. Expand sewage treatment plant up to existing rated capacity where no new land is required.

3. Install chemical or other process equipment; provide additional treatment facilities in existing lagoons, such as aeration, chemical additions, post treatment; construct associated facilities in existing pumping stations.

4. Replace individual septic systems with alternative individual treatment plants.

5. Expand buffer zone between lagoon facility or land treatment area and adjacent uses.

6. Dispose, utilize, or manage on an interim basis (e.g. further treatment of sludge at drying beds, composting, temporary holding at transfer stations), sludge at an existing sewage treatment plant where the sludge is generated; or at an existing landfill, incineration or organic soil conditioning site, where the sludge is to be utilized or disposed of.

7. Establish sewage collection system and all necessary works to connect the system to an existing sewage or natural drainage outlet, provided all such facilities are to be located in road allowances clearly shown on approved development plans and/or utility corridors clearly shown on approved development plans.

8. Establish a new sludge organic soil condition site.

TABLE 3-2 (CONT'D). PCP PROJECTS SUBJECT TO CLASS EA CATEGORIES

SCHEDULE B: Activities Proposed for Exemption Subject to Screening

1. Establish sewage collection system in existing road allowance, wherein there exists a road which is currently being used to carry vehicular traffic for at least three seasons of the year, or a utility corridor, wherein there exists a utility.
2. Establish sewage collection system not in a road allowance shown on approved development plans nor in a utility corridor shown on approved development plans.
3. Construct new storm water retention and detention ponds.
4. Increase size of existing communal septic tank or tile field at substantially the same location.
5. Extend, enlarge or add additional outfall in existing receiving waters.
6. Add flow equalization tankage at existing sewage treatment plant for influent and/or effluent control.
7. Establish interim sludge management facilities at: a sewage treatment plant where the sludge was not generated; or an existing landfill, incineration or organic soil conditioning site where the sludge is not to be disposed of nor utilized.
8. Retire (e.g. demolition, abandonment, decommission, etc.), a sewage facility, which facility was subject to the Act for its establishment.
9. Increase pumping station capacity by adding or replacing equipment and appurtenances where new equipment is located in a new structure.
10. Installation or replacement of standby power equipment where new equipment is located in a new structure.
11. Expand sewage treatment plant up to existing rated capacity where new land is required.

SCHEDULE C: Activities Subject to The Class Environment Assessment Process

1. Construct new sewage system.
2. Establish sewage collection system not in existing road allowance or existing utility corridor.
3. Expand existing sewage treatment plant beyond existing rated capacity.
4. Add additional lagoon cells to an existing sewage system.
5. Establish an outfall in a new receiving water body.
6. Provide for land application of effluent through spray irrigation system or overland flow.
7. Dispose of, utilize or manage sludge on an interim basis at a new sludge landfill site or new sludge incineration site.
8. Manage sludge at a transfer station or storage lagoon not located at a sewage treatment plant, incineration site, landfill site, nor organic soil conditioning site.

As noted in Table 3-2, Schedule A activities are exempt from Class EA requirements while Schedule B will require some screening by interested agencies before the appropriate Class EA category is determined. The screening process may result in a "bump-up" of projects. "Bumped-up" projects and those projects listed in Schedule C would require an Environmental Study Report (ESR) receiving government-wide review and a formal public consultation process. The format and requirements of the ESR are provided in the MEA report.

Most projects resulting from a PCP would fall under the Schedule A or B categories. The notable exception is the expansion of existing sewage treatment facilities beyond present rated capacity.

A PCP where Schedule A projects or activities are anticipated would require no special consideration of EA requirements during PCP preparation. A PCP where Schedule B projects are anticipated, should ensure that Class EA requirements can be met with a minimum of additional effort and where Schedule C projects are anticipated, PCP preparation will require full integration with Class EA procedures.

The likely Class EA category(s) of potential PCP projects should be identified as early as possible. Ideally, part of the PCP terms of reference should identify potential project categories and stipulate additional study requirements including those for public consultation and the preparation of a separate ESR.

3.6 **MOE Capital Construction Grant Program**

The Ministry of the Environment presently provides grants for sewage works and the cost associated with engineering these works. Since PCP preparation will often result in capital projects, and since the process itself can be viewed as a preliminary design activity, it is important to integrate the PCP with the Capital Construction Grant Program.

The underlying rationale for MOE providing some capital financing relief is expressed by the program objectives as follows:

1. To remove all water-borne health hazards for the protection of the people of Ontario.

2. To protect, through abatement and prevention of pollution, the natural environment and water resources and the aquatic environment in particular.
3. To accommodate and promote the plans for growth of the Province and to support local residential and industrial growth concepts.
4. To provide for community enhancement in terms of improving environmental or service standards above normally acceptable levels and/or providing balanced services.

Grant eligibility is predicated both on the nature of works to be undertaken and the priority of the problem the works is intended to address. A minimum priority is necessary before proposed works are considered grant eligible. Level of funding is determined by community size with municipalities above 7,500 receiving a grant of 15% of eligible costs. For small municipalities (below 7,500) grants of up to 85% are available for capital costs in excess of a threshold value that the municipality must pay. For municipalities <7,500 people, the percent grant is calculated according to the formula:

$$\% \text{ Grant} = 95.77 - 0.01077 \times \text{POPULATION} \quad \text{(based upon the assessment rolls)}$$

In municipalities under regional government, the cost of the grant portion is shared between MOE and the regional government. The Ministry's Project Engineering Section should be contacted for further details.

Table 3-3 provides an overview of the existing program pertaining to communal sewage works.

TABLE 3-3. OVERVIEW OF MOE CAPITAL CONSTRUCTION GRANT PROGRAM

Nature of Eligible Works

Major works only, including treatment facilities, trunk sewers, pumping stations and force mains and outfalls.

Eligible Costs

Land, legal and engineering costs, only land used directly for the works or to provide a suitable buffer are grant eligible.

Level of Funding

>7,500 persons - 15% of net capital costs (net of other grants and subsidies).

<7,500 persons - up to 85% of net capital costs above threshold limit according to formula and other factors noted above.

Grant eligibility is extended on a case-specific basis to major storm drainage works where those works have sanitary benefit. For example, where new storm trunk sewers are installed as part of a combined sewer separation program, some portion of the cost of the storm drainage is fundable by the Province. The eligible fraction is that which provides sanitary benefit to the community. A numerical example illustrates the principal.

Example - Funding of Storm Drainage Works

- Community A - population 20,000
  - combined sewer system
- Separation program uses existing combined sewers for sanitary servicing and provides new storm sewers for road drainage.

Cost Analysis

			Cost $K
1)	New storm sewers		1,500
2)	Equivalent value of sanitary capacity achieved by separation		1,000
	Therefore, Grant Eligible Cost	=	1,000
	Grant @ 15%	=	150

The payment of grants is made in the form of advances based on projected expenditures. Payments are initiated only after the award of contracts. Any engineering, legal and land acquisition costs are carried wholly by the municipality until after award of contracts.

It is suggested that the municipalities needing a PCP should be identified to the MOE group(s) responsible for the capital works program. All requests for capital assistance from these municipalities could then be tied to PCP preparations. For example, the output of the cursory assessment could be used to develop ratings of projects proposed under the PCP.

3.7 MOE Value Engineering Program

The objective of Value Engineering is to maximize the effectiveness of funds expended on capital works under the MOE Grant Program. Value Engineering technical review is applied preferably at the earliest possible design stage, with the objective of identifying cost-effective design alternatives and cost-effective designs of a given alternative. As practiced by the MOE, Value Engineering first identifies deficient alternatives and designs and suggests improvements. If changes are not instituted by the project proponent, grant calculations are based on what is felt to be the most efficient alternative.

The effectiveness of a Value Engineering program is greatest when changes can be made at an early stage in the design process. It is important therefore, to have adequate information for Value Engineering decisions as early as possible. The PCP cursory assessment is an ideal vehicle to provide the necessary data. Accordingly, Value Engineering staff should be consulted early in PCP preparation to identify their interests in any potential projects resulting from the PCP and to identify their information needs with respect to those projects. PCP Terms of Reference should then be prepared incorporating, where possible, Value Engineering requirements. Furthermore, cursory assessment review should include Value Engineering staff when they have identified an interest in potential PCP projects.

3.8 Determination of Treatment Requirments for Municipal and Private Sewage Treatment Works Discharging to Surface Water (MOE Policy 08-01)

The above MOE policy (MOE, 1983) takes the approach of establishing a "normal" (secondary) level of treatment which must be provided unless individual receiving water assessment studies either indicate the need for higher levels of treatment (e.g. tertiary) or suggest that a relaxation of the "normal" treatment requirment can be considered. The minimum level of treatment considered acceptable is primary treatment plus disinfection.

Some areas in Ontario identified for possible relaxation include St. Mary's River, Niagara River, St. Lawrence River, Ottawa River and others. Treatment plants discharging to embayments may require a higher degree of treatment, if the embayment has insufficient dilution, dispersion or assimilation capacity.

The policy further states that by-passing of raw sewage from separate sewerage systems will not be allowed except in emergency conditions. Emergency by-passes are those considered necessary to protect against basement flooding or to prevent process washout or equipment damage at the treatment plant. It is possible in some instances that the above requirements may serve as a constraint during the alternative selection stage of the PCP.

3.8.1 Requirements for Municipal and Private Combined Sewer Systems

Requirements for combined sewer systems are presently being drafted (MOE, 1983). Since the discharge of untreated wastewater represents a potential health hazard, the long term, ultimate, Provincial goal is the total abatement of all untreated combined sewer overflows (C.S.O.). It is recognized that achievement of this goal will require considerable investment in both time and monies. Consequently, for the interim, requirements for combined sewer performance will likely be based on the following:

i) prohibition of any dry weather discharges,
ii) an interim level of wet weather control established on a case-by-case basis.

3.9 Great Lakes Water Quality Agreement

In 1978 the governments of Canada and USA signed the Great Lakes Water Quality Agreement (IJC, 1978). The two countries agreed to make a maximum effort to develop programs, practices and technology necessary for a better understanding of the Great Lakes Basin Ecosystem and to eliminate and reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes System. Obviously, this agreement will be relevant to PCP planning for municipalities which discharge effluents to the Great Lakes or streams tributary to the Great Lakes. Policies of the Agreement include:

(1) prohibition of the discharge of toxic substances in toxic amounts, and
(2) virtual elimination of the discharge of any or all persistent toxic substances.

The Agreement covers among other things, pollution from municipal and industrial sources, pollution from agricultural, forestry and other land-use activities, pollution from shipping and dredging activities and pollution from onshore and offshore facilities. In addition, the Agreement establishes specific water quality objectives for persistant toxic substances (organic and inorganic) and nonpersistent toxic substances. Lists are also established for hazardous (271 substances) and potentially hazardous (106 substances) polluting substances.

In October of 1983, the governments of Canada and the United States enacted a supplementary agreement (IJC, 1983) amending the Great Lakes Water Quality Agreement. The purpose of the supplement was to outline phosphorus target loads and required further loading reductions and to suggest suitable control measures.

The following highlights major elements of the phosphorus control programs and measures.

a) Municipal Waste Treatment Facilities
  - Efforts will be continued and intensified to ensure that municipal waste treatment facilities discharging more than 4,545 m^3/day (1 IMGD) achieve the 1 mg/L total phosphorus in the effluents.
  - Higher levels of P-removal may be required at some facilities.
  - Facilities built after October 1, 1983 should allow for P-removal to lower than 1 mg/L effluent concentration.

b) Nonpoint Source Programs and Measures
  - Priority management areas will be identified and urban drainage and agricultural nonpoint source control programs will be instituted where feasible.

3.10 Strategic Planning for Ontario Fisheries

The Ministry of Natural Resources (MNR) is currently in the process of developing District Fisheries management plans as part of their overall program for Strategic Planning for Ontario Fisheries (SPOF). MNR has 46 Districts in Ontario. The four key strategies of the plan for effective management of Ontario Fisheries (Anon, 1976) are:

(1) Using available knowledge to manage fisheries and conflicting uses of the environment more effectively.

(2) Develop new broader knowledge base essential for more effective future management of Ontario fisheries.

(3) Create and develop mechanisms for positive and effective public involvement in management decision-making.

(4) Adopt a "user pays" principle and capture, from the users of the fishery, a resource rent which reflects more rationally the value of benefits received and the true cost of future effective management.

The overall goal of SPOF is to protect, rehabilitate, enhance and maintain Ontario's fish communities and their environment to provide an optimum contribution of fish, fishing opportunities and associated benefits to society. Because of the close link between water quality and fisheries, it is anticipated that there will be specific interrelationships between the PCP, and District Fisheries Management Plans, and therefore, the PCP planner should be aware of these. For example, a subordinate strategy of (1) above, states "Ensure that environmental quality criteria essential to the health of components of aquatic communities are being met by providing input to agencies who establish them, by monitoring relevant water quality parameters and by insisting on appropriate action by the environmental protection agencies when criteria are not met".

CHAPTER 4

IMPLEMENTATION PROCEDURES AND TERMS OF REFERENCE

This chapter provides information regarding the suggested procedural approach for PCP implementation as well as giving some direction regarding the scope of a PCP and the setting of PCP terms of reference.

4.1 PCP Initiation

MOE Regions in consultation with affected municipalities will establish the need and timing of PCP preparation. MOE head office branches (i.e. Water Resources, Environment Approvals and Project Engineering, Environmental Assessment) as well as other interested government ministries and agencies will be consulted as is appropriate.

PCP preparation is recommended on an "as needed" basis for Ontario municipalities which are of sufficient population to produce significant water quality impacts. Below a population level of 10,000 persons it is difficult to justify the costs of comprehensive pollution control planning in relation to the anticipated benefits. Furthermore, it is doubtful whether smaller communities possess the in-house resources to properly manage PCP preparation. Some small municipalities may nevertheless require a PCP. For these cases, an upper tier municipality should provide technical and administrative assistance, or where no Regional government exists, MOE may, at its discretion, provide the needed support.

The conditions that may necessitate PCP preparation in municipalities are:

1) Advanced treatment is proposed and there exists a combination of other inputs (i.e. municipal, industrial and agricultural) whose control may provide a more cost-effective means of water quality management.
2) There exists, or is anticipated to exist, a requirement for stormwater quality management in an area tributary to a body of water receiving other pollutant inputs.

3) There exists or is anticipated to exist a combination of discharges from municipal and/or industrial and/or agricultural sources that interact to produce violations of the Provincial Water Quality Objectives (PWQO) or to produce conditions which deny desired beneficial water uses.

4) The preparation or updating of a watershed or master drainage plan; the water quality aspect of the plan may necessitate comprehensive pollution control planning.

5) The municipality is serviced by a combined or partially combined sewer system or is serviced by a nominally separate sewer system, which carries significant wet weather flows periodically producing either sanitary bypass or impairment of treatment processes resulting in reduced effluent quality. In addition, PCP preparation may be considered if wet weather flows result in basement flooding and/or physical damage to the sewage conveyance and treatment facilities. The latter are symptomatic of wet weather sewerage problems and are often associated with bypass or overflow.

Where PCP preparation is in response to existing water quality problems, it is suggested that the Region identify and prioritize the municipalites in this category. The Region will then encourage and negotiate with the affected municipalities, indicating the need for and the benefits of PCP preparation and the preferred timing. In general, unless water quality problems are severe, negotiation will lead PCP initiation by six months or longer. This will enable the municipality to prepare suitable terms of reference.

Where sewage works, water management planning activities, or water quality problems are anticipated, the Ministry will notify the affected municipalities and/or industries of the need to prepare a PCP. A lead time of six months or longer will be provided prior to strategy initiation for preparation of terms of reference, any multi-party agreements and the selection of a consultant(s) if necessary. Since the cursory assessment phase of PCP preparation will require approximately one year to complete, an overall lead time of 1-1/2 years or longer should be allowed for in advance of planned undertakings. In the case of watershed or master drainage planning, it may be possible to concurrently prepare a PCP, and hence, the lead time would be reduced.

Where PCP preparation is in support of other planning activities, it will be the responsibility of the lead planning agency (e.g. Conservation Authority in the case of watershed plans) to identify the need for and the benefits of PCP preparation and inform the Ministry Region.

4.2 PCP Scope

The scope of a Pollution Control Plan will be dictated by geographic, jurisdictional and technical considerations. The preparation of a given strategy may encompass an entire watershed or lakeshore or be restricted to a specific reach. The plan may also encompass a number of receiving water bodies such as when a large sewershed (sewer system tributary to a single treatment facility) is analyzed.

Plan preparation may be: i) restricted to a single municipality, ii) the integrated effort of a two-tier municipality, iii) carried out cooperatively by separate municipal entities, and iv) the joint undertaking of a municipality and/or industrial and/or agricultual discharge or dischargers. In addition, other agencies such as Conservation Authorities may have a concern in strategy preparation, and may, in some cases directly participate. The preparation of multi-party strategies will necessitate more effort, both in developing terms of reference and the subsequent strategy preparation. In addition, where capital construction depends upon the results of a multi-party PCP, extra lead time will be required.

Municipalities that are part of area-wide treatment schemes or who fall under a Regional or Metropolitan municipal government may need to prepare a multi-party PCP. In the latter case jurisdiction over sewerage and treatment facilities as well as industrial abatement is split between the lower and upper tier municipalities.

In most municipalities within the potential PCP target group, there will exist some prior studies or components of studies relevant to the PCP. Full account should be taken of these studies when setting PCP terms of reference and throughout the PCP assessment phase (detailed and cursory). The extent to which previous work can be incorporated will be highly case specific.

4.3 PCP Terms of Reference

At an early stage of the PCP process it will be necessary to develop terms of reference. Preparation of terms of reference is a critical stage in PCP development since it is the first opportunity to provide an extended definition of the problem(s) the PCP is intended to address. Furthermore, where PCP preparation entails more than one party, the terms of reference set out the administrative, financial and work-sharing agreements among the participating municipalities and agencies.

The terms of reference should be developed as a document outlining the objectives of the study and specifying in as much detail as needed (or possible) the steps to meeting those objectives.

For a simple PCP where only a single municipality is involved, it will be the responsibility of that municipality to prepare PCP terms of reference. The Ministry of the Environment through its Regions and its Water Resources Branch may be contacted for assistance and advice.

Where a multi-party PCP is required a lead agency will be identified by consensus of participating municipalities and agencies to co-ordinate PCP preparation. Depending upon the reason for undertaking the PCP and jurisdictional considerations the lead agency may be:

i) The Ministry (Head Office or Region)

This may be the case where separate municipal entities are to prepare a PCP or a joint municipal-industrial, municipal-agricultural or municipal-industrial-agricultural PCP is needed. The Ministry may also co-ordinate when the PCP is part of special watershed or shoreline studies whose principal focus is quality management.

ii) A Conservation Authority

This may be the case when PCP preparation is part of a larger watershed or shoreline planning exercise.

iii) An Upper Tier Municipality

This may be the case when a number of lower tier municipalites in a metropolitan or Regional area jointly prepare a PCP. PCP preparation for large sewersheds is an example of this case.

The lead agency will initially co-ordinate preparation of terms of reference and subsequently, co-ordinate PCP preparation. The lead agency will also assist in negotiating cost and work-share agreements and chair any committee(s) charged with steering PCP studies. The lead agency may choose to retain a consultant(s) for assistance in carrying out these tasks, particularly in the case of complex Pollution Control plans.

The following outlines the suggested format for PCP Terms of Reference:

4.3.1 Introduction

The introductory section of the terms of reference should outline:

- the purpose of the terms of reference
- background to the PCP (e.g. why it was needed, related previous studies

4.3.2 Objectives

The objectives of PCP preparation as a whole (not just cursory assessment phase) should be clearly and concisely stated. Table 4-1 presents a rather comprehensive set of objectives taken from the Rideau River Stormwater Management Study, RRSMS (1983). It should be noted that not every or even many PCP will require as extensive a statement of objectives.

4.3.3 Problem Definition and PCP Technical Aspects

The need for a PCP stems from the perception of an existing or anticipated water quality problem as was outlined in Section 4.1. Accordingly, a concise statement of the problem(s) the PCP is intended to address should be included in the terms of reference. The problem statement will generally be based upon previous work (e.g. water quality assessment, evaluation of anticipated impacts from new developments) and should include but is not restricted to the following items:

- boundaries of PCP area
- water body(s) affected
- water quality criteria defining problem

TABLE 4-1. RIDEAU RIVER STORMWATER MANAGEMENT STUDY OBJECTIVES

1. To determine the magnitude of pollutant loads to the Rideau River from urban stormwater runoff, combined sewer overflows, agricultural drainage and upstream sources under existing conditions.
2. To determine the effects the loadings and existing hydraulic conditions have on the Rideau River.
3. To predict the pollutant loads expected, and the effect on the Rideau River from future urban developments.
4. To determine the assimilative capacity and allowable pollutant loads to the Rideau River to achieve acceptable water quality for existing and future urbanization, according to Ministry of Environment guidelines and criteria.
5. To determine the effectiveness of existing stormwater management facilities under different operating conditions.
6. To assess the effectiveness and cost of various control measures for meeting specific quality requirements at various locations on the Rideau River, including the planned combined sewer control program of the City of Ottawa.
7. To coordinate the study with ongoing studies on specific tributaries and to explore summer flow augmentation by additional storage in the Rideau River system.
8. To provide continued support to interim stormwater management programs.
9. To recommend a comprehensive stormwater management program which will achieve environmental and economic objectives.
10. To identify in consultation with all local recreational authorities:
    a) the swimming needs of the Regional Community with respect to the Rideau River as may be identified from an investigation of the swimming desires of the people of the Region; and
    b) the most practical bathing areas, on the basis of identified swimming needs, existing and forecast pollutant loadings and the assimilative capacity of the river for pollution.

- likely sources of pollutants including the nature of the sources and their approximate location
- nature of any adverse water quality impacts (e.g. fish kills)

4.3.4 Project Organization and Administrative Arrangements

This section of the terms of reference should outline how, when and by whom the PCP will be carried out as well as giving an indication of the planned means of involving the public.

The following provides some of the major considerations.

PCP Timing

An overall timetable for PCP development should be prepared. Any important deadlines for capital works or other actions depending on the PCP should be identified.

Resources

A preliminary estimate of resources required to carry out PCP studies should be made and the nature and source of the resources should be identified. The types of resources that participating parties may contribute would be:

- monetary
- manpower
- laboratory support
- equipment and supplies

Parties Involved in PCP Preparation

The parties actually carrying out PCP investigations should be identified as well as the tasks they are expected to carry out. In general, divisions will be along the lines of political jurisdiction. For example, if two municipalities both discharge to a river system they would be responsible for studies within their boundaries. Where multiple jurisdiction exists within a municipal area (e.g. two-tier government with one tier responsible for treatment and one for collection of sanitary wastewater) and depending upon the circumstances the senior level of government should take overall responsibility for the studies to ensure to a co-ordinated approach.

Other interested parties taking a less an active role in PCP preparation should also be identified as well as the nature of their involvement (e.g. advisory, regulatory, etc.). It should also be noted that in some cases it may be difficult if not impossible to identify all parties that should be involved in a PCP at the time terms of reference are prepared. Since PCP preparation is dynamic new participants can be added at any stage.

Lead Agency

Tied closely to the identification of the parties participating in PCP preparation is the identification of a lead agency.

The agencies potentially asked to provide a lead role were previously discussed in this section.

Other Planning and Approval Processes

Identify requirements of external funding, planning or approval processes such as Environmental Assessment, Provincial Capital Construction Grants, Value Engineering review, master drainage or watershed planning and incorporate these requirements where possible into PCP preparation.

Administrative Arrangements

Terms of reference should identify the management structure supervising PCP studies. For simple PCP involving a single municipality the normal interface between MOE and the municipality should suffice. In contrast, where multi-party PCP are envisaged, the administrative structures should become more formalized. It is difficult to a priori specify the best arrangement for each circumstance, nevertheless a few suggestions follow:

- A steering committee responsible for the technical and budgetary aspects of the study be formed from active study participants.
- If need be, other parties not directly involved in PCP preparation but having specific interests be asked to participate in an advisory group. The interests of citizens groups can be addressed in this fashion.
- An individual preferably from the lead agency should be nominated to co-ordinate study activities.

4.3.5 **Public Involvement**

The nature and details of public involvement should be specified as well as a timetable indicating the likely point(s) in the study when public dialogue would occur.

4.3.6 Relevant Background Material (in Appendices)

Relevant previous or ongoing studies, data bases, etc. should be listed and the source and availability of any documentaton describing the above should be indicated.

Once terms of reference have been completed and have, in the case of multi-party PCP, been circulated for review by the participants they should be submitted to the Ministry of the Environment Region for review and concurrence.

4.4 PCP Output and Review

PCP output will be in the form of a summary report. Chapter 9 provides details of suggested report format. The summary report should identify the management actions required of each participating party. The PCP summary report may serve as a preliminary design report for structural alternatives. It may also partially or wholly satisfy environmental assessment requirements. The Ministry's Region or Environmental Assessment Branch should be contacted prior to finalizing the PCP to ensure that maximum subsequent use can be made of the documents. It must be understood though, that PCP preparation in no way exempts proponents of specified reportings from the normal approval and environmental assessment requirements. Simply, the PCP process can consolidate these requirments.

The summary report dealing with a cursory assessment for a simple PCP should be submitted upon completion to the Ministry Region for review and concurrence. Where a multi-party assessment has been prepared the review process will, of necessity, be more complex. It will be the responsibility of the lead agency to co-ordinate the review and assist in formulating a consensus position. The finalized cursory assessment should then be forwarded to the Ministry Region for review and concurrence. Expert assistance in reviewing PCP submissions is available through the Ministry's Water Resources Branch with respect to the pollution assessments and through the Environmental Approvals and Project Engineering Branch with respect to cost evaluations.

Review procedures for detailed assessments are similar to those indicated above.

CHAPTER 5

CURSORY ASSESSMENT PROCEDURES

5.1 Introduction and Objectives

The objectives of the assessment phase (cursory and detailed) of PCP preparation are to carry out technical analyses leading to:

- A definition of the water quality problem(s) or anticipated water quality problem(s) in as concrete a manner as possible linking cause (pollutant source) and effect (water quality impact preferably as described by objective criteria; e.g. D.O. depletion).
- A pollution control plan identifying the measures necessary to achieve the desired water quality.

The cursory assessment is the second step in problem definition since an extended outline of the water quality problem(s) has already been prepared in the terms of reference. The cursory assessment takes the original problem outline and attempts to define the characteristics, distribution and magnitude of all significant pollutant sources in the municipality and the probable impact of the pollutant sources on receiving water quality under dry and wet weather conditions. The problem definition is carried out wherever possible with specific reference to provincial water quality objectives (e.g. heavy metals, un-ionized ammonia). The problem definition should also extend to describing the influence of adverse water quality upon beneficial uses (if any). For example, where water quality conditions may be adverse for bathing use but no bathing is possible or envisaged (e.g. ship docking area) a lesser priority may be given to addressing this problem. Although some care should be exercised in cases of this nature, because environmental interactions are often subtle.

The cursory assessment is the first point in PCP development where potential control measures or abatement actions are considered. The process of developing pollution control plans should be initiated as early as possible even while problem definition is ongoing. Indeed it is worthwhile to try to document possible control measures and abatement programs and the criteria by which their desirability will be judged in advance of proceeding with extensive problem assessment. In this manner one can insure that data collection and analysis will be matched to the information needs connected with making pollution control decisions.

Emphasis should be placed on carrying out the cursory assessment using the simplest possible approach with as much reliance as possible on existing data sources.

In general, the cursory assessment will have as limited a field component as is feasible consistent with achieving desired results. It may however be necessary to include a field investigation component of, for example a previously uncharacterized pollutant source (e.g. sanitary cross-connections made to storm sewers).

The stages in the preparation of a cursory assessment and the specific elements of each stage are depicted in Figure 5-1. The problem definition stage, as the name suggests, is intended to define cause-effect relationships and to assess the status of present pollution control facilities. In addition, the influence of future community growth upon both the pollutant sources and the future capacity of pollution control facilities are examined. Each of the components are described in further detail in this chapter.

The next stage of cursory assessment preparation may or may not proceed to completion depending upon the availability and utility of existing data. The objective of this stage is to develop suitable control measures or groups of measures into alternative pollution control plans and to identify by means of objective criteria the most desirable pollution control plan.

It must be emphasized that the division between problem definition and plan formulation is largely arbitrary and that as previously noted development of evaluation criteria and pollution control alternatives should be carried out in parallel.

As shown in Figure 5-1, the cursory assessment (limited or full-scope) may result in one of a number of possible outputs. If water quality problems and pollution control alternatives are well defined and the existing data base is adequate for decision making the process can proceed to a finalized PCP presented in a PCP summary report. If on the other hand the existing data does not lend itself to a useful problem definition or the formulation of a pollution control plan, the output of the cursory assessment may be one or all of the following:

- identification of additional technical analyses to be carried out under a detailed assessment
- revised study terms of reference
- recommendations for immediate abatement actions or interim controls

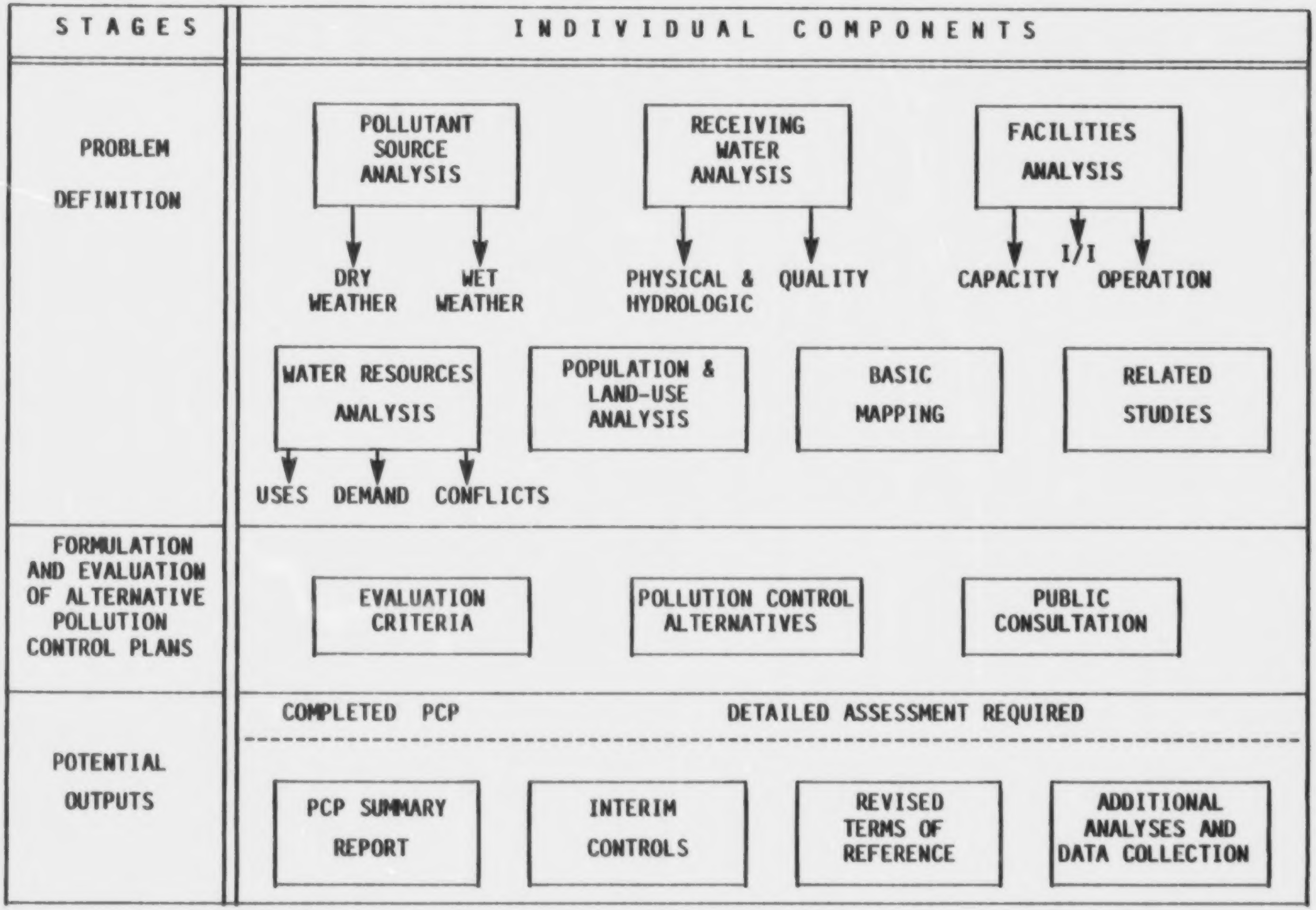

STAGES
INDIVIDUAL COMPONENTS
PROBLEM DEFINITION
POLLUTANT SOURCE ANALYSIS
DRY WEATHER
WET WEATHER
RECEIVING WATER ANALYSIS
PHYSICAL & HYDROLOGIC
QUALITY
FACILITIES ANALYSIS
CAPACITY
I/I
OPERATION
WATER RESOURCES ANALYSIS
USES
DEMAND
CONFLICTS
POPULATION & LAND-USE ANALYSIS
BASIC MAPPING
RELATED STUDIES
FORMULATION AND EVALUATION OF ALTERNATIVE POLLUTION CONTROL PLANS
EVALUATION CRITERIA
POLLUTION CONTROL ALTERNATIVES
PUBLIC CONSULTATION
POTENTIAL OUTPUTS
COMPLETED PCP
DETAILED ASSESSMENT REQUIRED
PCP SUMMARY REPORT
INTERIM CONTROLS
REVISED TERMS OF REFERENCE
ADDITIONAL ANALYSES AND DATA COLLECTION

FIGURE 5-1 - STAGES AND INDIVIDUAL COMPONENTS OF THE CURSORY ASSESSMENT

Examples of interim controls include restrictions on new sewer connections, phasing planned developments, revised treatment plant operations, etc. In the case of municipalities with combined sewerage system, it is recognized that the ultimate goal of total abatement of combined sewer overflow (C.S.O.) may require considerable resources and time. Consequently, interim controls to minimize the impact of C.S.O. upon water resources will be necessary in many cases. Measures such as regulator consolidation, detention storage and high rate treatment all can provide a measure of C.S.O. control for the interim.

Interim controls may be adopted by the municipality acting on its own or they may be imposed by the regulatory agency, in this case, MOE.

5.2 Inventory and Analysis

5.2.1 Problem Simplification

Effective problem-solving involves working at the simplest level possible, while retaining the essential features of the overall problem (e.g. in the PCP process, it is often possible to analyse separately for the water quality problems associated with wet-weather and dry-weather conditions). It may also be appropriate to simplify a very complex problem by dealing with pollutants on an individual basis and then assessing the linkages, or similarities between the remedial alternatives. For example, if there are two pollutant sources of phosphorus contributing to a receiving stream and one additional source contains heavy metals, controls for phosphorus and heavy metals may be treated separately.

5.2.2 Basic Mapping of Area

A basic map(s) prepared for a PCP area is useful for documenting the physical features of the area to:

- identify spatial relationship between pollutant sources and receiving waters;
- delineate predominant features which could affect source-receiving water relationships and the type of analysis used to quantify these relationships;
- identify major pollutant sources (type, location and size);

- indicate major features of receiving water (e.g. dams, weirs, mixing zones etc.);
- delineate boundaries (watershed, political and other) for PCP area;
- breakdown of pollutant source contribution, in consideration of local features (e.g. upstream of lake or downstream of lake); give preliminary indication of potential upstream sources.

A map for a hypothetical PCP area, presented in Figure 5-2, illustrates some of the above items. Other specific mapping items are covered in subsequent sections.

5.2.3 Population and Land Use

Population data and population projections will be useful for future predictions of capacities required for sewer and treatment facilities and loadings to receiving waters from sanitary sewers, combined sewer overflows and separated storm sewers.

Present population figures should be broken down into total, sewered, nonsewered, water serviced and other relevant categories. In general, population projections should reflect various scenarios of economic growth and or development (e.g. high, medium and low). Population data are readily available from census files, municipal planning departments or public utilities records.

In general, land use in a PCP area will fall into either an urban or non-urban classification. Some municipalities may contain essentially 100% urban land whereas regional municipalities may also incorporate significant areas of non-urban land. Specific categories of land use as used by IJC-PLUARG (1977) in the Great Lakes Land Use Inventory are listed in Table 5-1. An example of land use delineation and its applicability in estimating pollutant loadings for Ontario municipalities, is provided in a report by Sullivan et al (1978). Present and future land use conditions should be determined for the PCP area.

Relevant sources of land use information for Ontario include official land use plans for municipalities or regions, Ministry of Natural Resources land use maps, soil survey maps for various counties (Department of Agriculture), Gierman and Ryerson (1974) and Theil et al (1973).

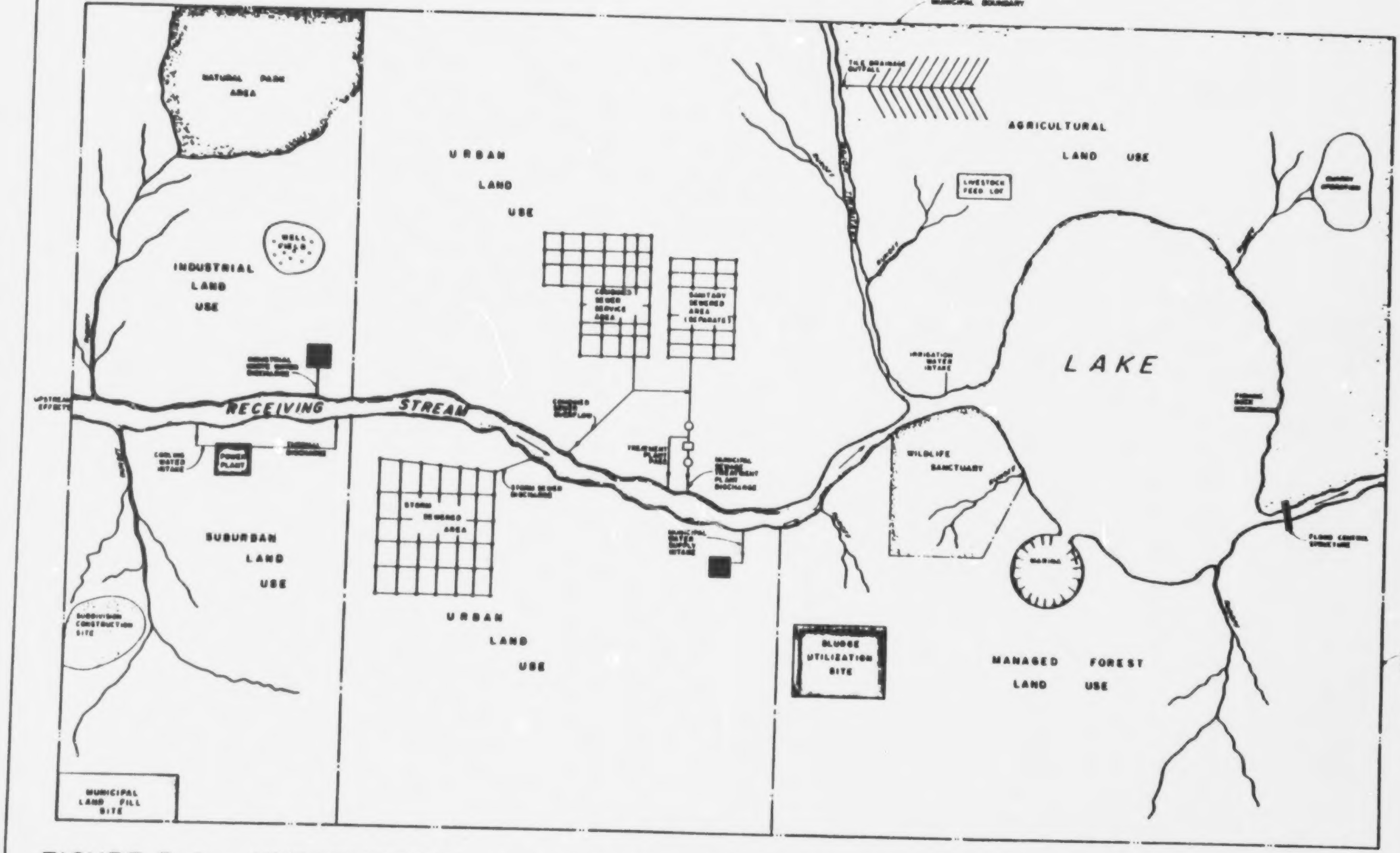

MUNICIPAL BOUNDARY
NATURAL PARK AREA
WELL FIELD
INDUSTRIAL LAND USE
UPSTREAM EFFECTS
RECEIVING STREAM
COOLING WATER INTAKE
POWER PLANT
THERMAL DISCHARGE
SUBURBAN LAND USE
SUBDIVISION CONSTRUCTION SITE
MUNICIPAL LAND FILL SITE
URBAN LAND USE
COMBINED SEWER SERVICE AREA
SANITARY SEWERED AREA (SEPARATE)
COMBINED SEWER OVERFLOW
TREATMENT PLANT SITE
MUNICIPAL SEWAGE TREATMENT PLANT DISCHARGE
STORM SEWER DISCHARGE
STORM SEWERED AREA
MUNICIPAL WATER SUPPLY INTAKE
URBAN LAND USE
SLUDGE UTILIZATION SITE
TILE DRAINAGE OUTFALL
LIVESTOCK FEED LOT
AGRICULTURAL LAND USE
IRRIGATION WATER INTAKE
LAKE
WILDLIFE SANCTUARY
MARINA
MANAGED FOREST LAND USE
FLOOD CONTROL STRUCTURE
MUNICIPAL BOUNDARY

FIGURE 5-2 —HYPOTHETICAL POLLUTION CONTROL PLAN (PCP) PLANNING AREA

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TABLE 5-1. LAND USE CLASSIFICATIONS (POLLUTION FROM LAND-USE ACTIVITY REFERENCE GROUP)(PLUARG, 1977)

CATEGORY	SUB CATEGORIES
Urban	Residential (low,medium and high density) Commercial-industrial (low, medium and high density) Transportation (rail, highway, airports, etc.)
Extractive	(mine, gravel pits, etc.)
Slag Heaps	(tailings disposal)
Outdoor Recreation	(parks, golf courses, etc.)
Agriculture	Orchards Cropland Improved Pasture Unimproved Pasture
Forest	
Marsh and Swamp	
Barren	(sand flats, rock, etc.)

5.2.4 Hydrological Data

It is important to determine the hydrologic characteristics of the receiving water (lake or stream). These data should be as site specific as possible. In most cases, unless the receiving water is very small or obscure, a gauging station will be available from which the appropriate information can be obtained. Potential data sources are summarized in Table 5-2.

Once stream flow records have been obtained, certain basic statistics should be derived, such as, mean monthly flow, minimum flow, critical low flows and recurrence intervals, peak monthly flows and base flow. For lakes morphological (depth, shoreline extent surface area, mean depth), stage fluctuations and hydraulic residence time data are essential. Logan (1977) provides further detail on methodologies for stream flow analyses germane to waste assimilation studies.

TABLE 5-2. SOURCES OF METEOROLOGICAL AND HYDROLOGICAL DATA FOR ONTARIO

SOURCE	AGENCY
Monthly Records of Meteorological Observations in Eastern Canada (various locations)	Atmospheric Environment Services Environment Canada
Monthly Radiation Summary (various locations)	Atmospheric Environment Services Environment Canada
Historical Stream Flow Summary: Ontario (various streams)	Water Resources Branch Water Survey of Canada Environment Canada
Runoff Conditions in Canada (1976)	Applied Hydrology Div. Water Resources Branch Environment Canada
Selected Stream Flow Data for Ontario (1971-78)	Water Resources Bulletin Surface Water Series Ontario Ministry of Environment (MOE)
Stream Flow Data for PLUARG (1975-77)	Water Resources Bulletin Surface Water Series MOE
Conservation Authority Reports	Conservation Authorities Branch, Ministry of Natural Resources (MNR)
Water Resources Surveys for Various Drainage Basins	Ontario Water Resources Commission (now MOE)
Bibliography of Hydrology: Canada (1971 -	International Association of Hydrological Sciences Environment Canada and National Research Council
Bibliography of Canadian Fresh Water (unpublished)	Canada Centre for Inland Waters (N.F. Nicholson)
Special Studies	Ontario Hydro Electric Commission, MOE, Universities

5.2.5 Topographic and Climatological Data

The quantity and the quality of run-off in a particular PCP area will be dependent upon the geophysical characteristics of the drainage basin(s), the land uses and control practices and the amount, frequency and intensity of rainfall.

Topographic information suitable for delineating watershed boundaries can generally be obtained from specific maps or sanitary sewer projects. Standard quadrangle maps available from the Surveys and Mapping Branch of Canadian Department of Energy Mines and Resources and air photos may provide sufficient detail for watershed separation. Climatological data (rainfall etc.) is available from numerous weather stations in Ontario (Table 5-2).

5.2.6 Water Quality Data

Many bodies of water in Ontario are monitored on a routine basis. However, the regularity of monitoring varies considerably. Typically these locations are monitored for dissolved oxygen, pH, nitrogen and phosphorus forms, temperature, dissolved solids/conductivity, turbidity, suspended solids, BOD_5, coliforms, selected heavy metals and major cations and anions. In a few cases, data for trace contaminants or toxic organics may be available. Potential water quality data sources are summarized in Table 5-3.

TABLE 5-3. WATER QUALITY DATA SOURCES

SOURCE	AGENCY
Water Quality Data Ontario Lakes and Streams (1964 - 1978)	Water Quality Data Series MOE
Data for Northern Ontario Water Resources Studies (1972 - 73)	Water Resources Bulletin MOE
Surface Water Data Canadian Rivers (Various Years)	Environment Canada
Limnological Data Reports Great Lakes	Canada Centre for Inland Waters
Special Studies by Conservation Authorities, MOE, MNR and others	e.g. Grand River and Thames River Studies

Field inspections of receiving water conditions in the PCP area during dry and wet weather will provide invaluable information on locations of significant wastewater discharges and non-point inflows, the areal extent of receiving water weed or algae problems, mixing characteristics of the receiving water and areas of excessive erosion and sediment loading.

5.2.7 Water Resources Analysis

The water resources analysis is intended to identify for the receiving water under evaluation:

(1) the beneficial uses (Chapter 2) made of the water body,
(2) the demands for these beneficial uses, and
(3) any conflicts arising from different uses.

This purpose of the analysis is to focus attention on water uses and to critically examine, from a community standpoint what the demands for these uses are, or may be, if water quality were improved. Data from this analysis may form part of the evaluation criteria for subsequent screening of pollution control plans.

5.2.8 Related Studies

Certain activities, although not directly impacting the PCP process, may interrelate with some components and provide valuable supplemental data. These could include:

- conservation authorities watershed plans,
- industrial surveys,
- groundwater management studies,
- master drainage plans (runoff quantity etc),
- stormwater management plans, and
- others (municipal planning reports, etc).

5.2.9 Pollutant Source Analysis

The pollutant source analysis is designed to provide the best estimate (without or with limited field measurements) of the nature and characteristics (temporal and spatial) of all potentially significant pollutant sources in the PCP study area under present and future conditions. This analysis should reflect the types of pollutants (Chapter 2), receiving water characteristics (e.g. stream versus lake) and the nature of the sources (point, non-point, etc.).

Two types of analysis are commonly carried out (i.e. mass loading and critical concentrations) with specific considerations being given to wet season and dry season effects. Spatial and temporal concentrations of some pollutants (e.g. bacteria, ammonia, chlorine and others) may be more critical in certain circumstances than mass loadings. For zero tolerance pollutants (Table 2-2) an incidence of any kind is of concern. The major types of sources are discussed in the following sections. Other more specialized sources such as landfill leachates and contributions from wildlife are not discussed. Reference should be made to the appropriate literature in these cases.

5.2.9.1 Continuous Point Sources

The loadings from industrial and municipal point sources can generally be estimated from existing wastewater flow and pollutant concentration monitoring data. For example, the Ministry of Environment publishes an annual operating summary (MOE, 1969 to 1980) for all municipal wastewater treatment facilities in Ontario. These summaries contain flow, BOD_5, suspended solids, nitrogen and total phosphorus data for plant influents and effluents.

Some municipalities (e.g. Region of Waterloo) collect data on major industrial discharges for purposes of surcharge calculations. In addition, most industries with their own treatment facilities are required to monitor the facility. If monitoring data are not available, then it may be possible to estimate loadings using data from a similar industry, production rates, or literature values. It is recommended that a survey of industries and their potential pollutant discharges be included as part of the cursory assessment.

If possible, BOD_5, suspended solids, total nitrogen, ammonia and total phosphorus mass loadings and concentration range should be compiled for each point source. A comparison of the relative magnitudes of the individual loadings may result in the early elimination of certain insignificant sources.

5.2.9.2 Tributary Sources

When monitoring data are available, tributary loadings can readily be calculated. However, it may be necessary in many cases to estimate loadings using literature values and land use information. For further detail on estimation procedures refer to EPA (1976).

5.2.9.3 Intermittent Urban Sources

Intermittent urban pollutant sources can be generally classified as dry weather and wet weather. Dry weather sources include groundwater seepage from storm or combined sewer outfalls, illegal discharges to storm outfalls either from residential/commercial sanitary sources or from industry and overflows or bypasses of untreated wastewater occuring in periods free from precipitation or the influence of snowmelt. Wet weather intermittent discharges result from stormwater runoff, combined sewer overflow and bypass from separate sanitary systems.

A number of methods are available for estimating the loadings from the wet weather sources. However, many of these procedures are too complex and time consuming to be used for the cursory assessment. Methods are required that can give approximate results which are suitable for comparative purposes (e.g. comparing the magnitude of sewage treatment plant and combined sewer overflow mass loadings to the receiving water). Some simple procedures for estimating combined sewer overflow and storm sewer loadings are summarized in Table 5-4. The procedures are arranged in approximate order of increasing complexity.

Intermittent dry weather pollutant loadings are considerably more difficult to estimate. Estimation of loads from seepage or illegal discharges is usually achieved by means of an outfall survey sometimes also called a sanitary survey. In an outfall survey all outfalls in the river reach on shoreline area of interest are identified and grab samples and spot flow

TABLE 5-4. SIMPLE PROCEDURES FOR ESTIMATING INTERMITTENT URBAN POLLUTANT LOADINGS

PROCEDURE	BRIEF DESCRIPTION	REFERENCE
Average quantity of runoff Average pollutant concentration of runoff	$W_o = \bar{c}\ \bar{C}_v\ I_T\ A$ W_o = loading for period of averaging where $\bar{c}$ = average pollutant concentration $\bar{C}_v$ = average runoff coefficient I_T = average rainfall divided by period of averaging A = drainage area	EPA (1976)
Annual pollutant loads	Utilizes land use information and literature values for unit loadings to compute loadings for a variety of pollutants	Marsalek (1978)
APWA unit load	$L = a\ P\ (b + cD^d)$ where L = annual unit load (kg/ha) P = annual precipitation (m) D = population density a, b, c and d are experimentally derived parameters	Sullivan et al (1978)

measurements are carried out at each flowing outfall on a number of occasions. The pollutant loading originating from seepage is estimated from data derived from uncontaminated outfalls and the unit area loading appropriate to the catchment(s) is developed. The total seepage loading is then calculated for the area of interest (unit load x total catchment area) and the loading from illegal sources is computed as the difference between total observed loading (all outfalls) minus the total seepage loading. Reference can be made to the recent survey of Humber River outfalls Gartner-Lee (1983) for details of survey methodology.

5.2.9.4 Non-Urban Sources

Some PCP areas (e.g. a regional municipality) may contain significant areas of non-urban land which may in turn contribute pollutant loadings to the receiving water (See Figure 5-2).

A methodology for estimating loadings similar to the EPA procedure in Table 5-4 can be used for these sources. Alternatively, land use data and literature values for areal loadings can be employed. For example, some typical areal loadings are summarized in Table 5-5. Areal loadings for several Ontario watersheds, together with detailed application procedures are presented in reports by Hore and Ostry (1978) and Ostry and Tseng (1981). Wherever possible, areal loading values derived under similar conditions (soil, climate, agricultural practices, etc.) as the PCP area should be employed. Drynan and Davis (1978) describe a relatively simple procedure for estimating non point pollutant loadings based on application of the Universal Soil Loss Equation.

TABLE 5-5. ANNUAL UNIT AREA LOADS (KG/HA/DAY)
(EPA, 1983)

LAND-USE	TOTAL NITROGEN	TOTAL PHOSPHORUS	FILT'D REACTIVE PHOSPHORUS	SUSPENDED SOLIDS
General Agriculture	0.6 - 42	0.1 - 9.1	0.01 - 0.6	3 - 5600
Forest/Wooded	1.0 - 6.3	0.02 - 0.67	0.01 - 0.10	1 - 820
Improved Pasture	3.2 - 14	0.0 - 0.05	0.02 - 0.2	30 - 80
Cropland	4.3 - 31	0.2 - 4.6	0.05 - 0.4	20 - 5100
Idle/Perennial	0.5 - 6.0	0.02 - 0.67	0.01 - 0.07	7 - 820

5.2.9.5 Example of Pollutant Source Analyses

An example output for a pollutant source analysis for the Avon River in Stratford is presented in Figure 5-3. The wet season total phosphorus loadings are summarized in the pie diagram. In this particular case it is evident that the treatment plant effluent and bypasses are the most significant sources of phosphorus to the stretch of the Avon River. Stormwater and other sources (upstream loadings) are of considerably lower significance.

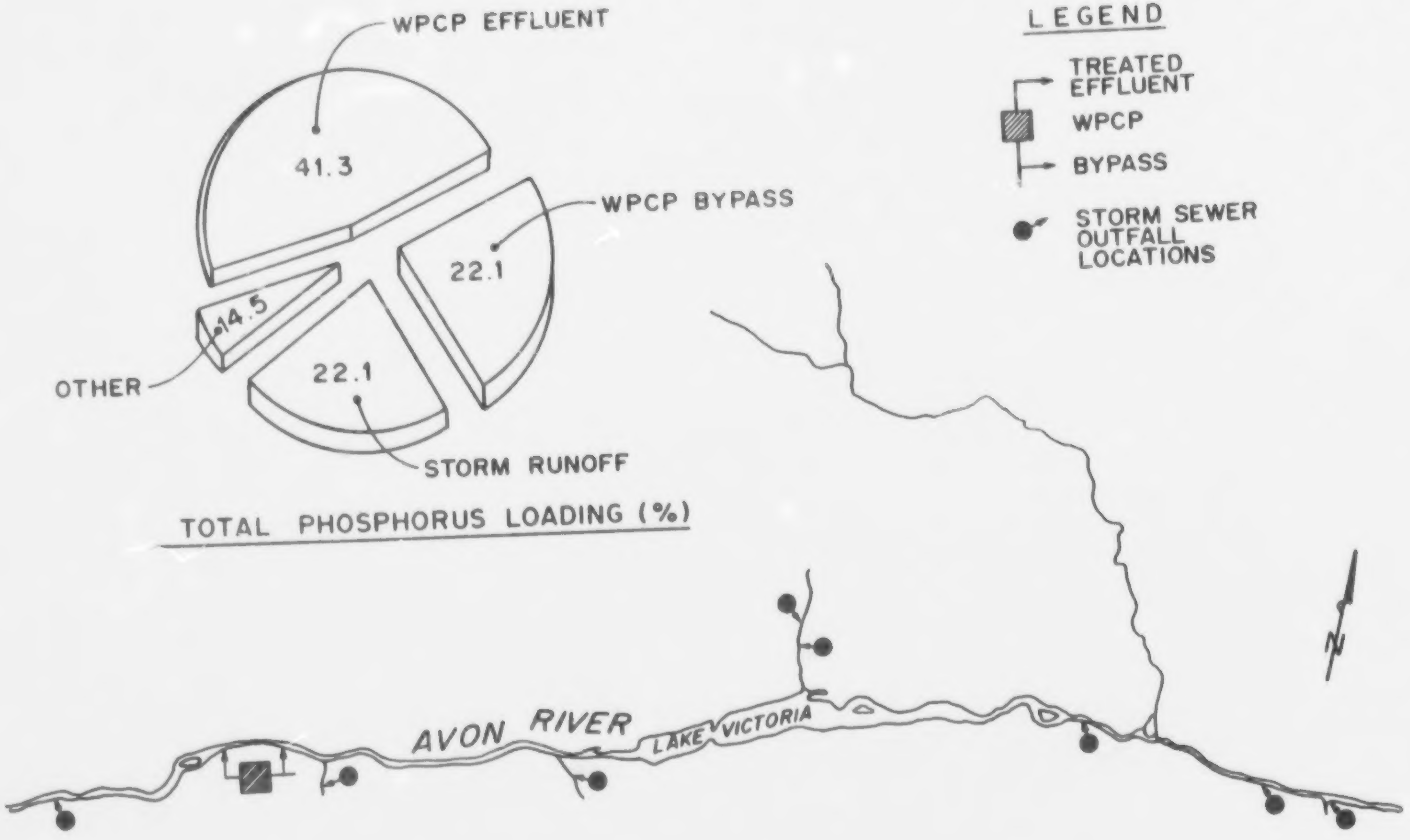

WPCP EFFLUENT
41.3
WPCP BYPASS
22.1
22.1
STORM RUNOFF
14.5
OTHER
TOTAL PHOSPHORUS LOADING (%)
LEGEND
TREATED EFFLUENT
WPCP
BYPASS
STORM SEWER OUTFALL LOCATIONS
N
AVON RIVER
LAKE VICTORIA

FIGURE 5-3 — WET SEASON POLLUTANT SOURCE ANALYSIS (TOTAL-P) FOR AVON RIVER IN STRATFORD (ZUKOVS AND ENGLER, 1982)

5.2.10 Receiving Water Analysis

The receiving water analysis is carried out to assess the impact of pollutant discharges on the receiving water under present and future land use conditions. Consequently, the analysis is closely coupled with the pollutant source analysis outlined in the previous sections. Procedures developed during the receiving water analyses are also utilized to assess the benefit, in terms of improved water quality, of various control measures for pollutant discharges.

In general, the receiving water analysis will consist of compiling and interpreting existing data to:

(1) Describe the physical, hydrologic, limnological (for lakes) characteristics of the receiving water which potentially influence pollutant dispersion and physical or chemical removal processes.

(2) Define existing water quality; i.e. define ambient (in absence of pollutant discharge) water quality if possible and water quality under impact of discharge.

(3) Identify the significant biological components of the receiving water that may be impacted by pollutant discharges or which may serve as indicators of water quality trends.

The methodologies employed for the receiving water assessment should be kept as simple as possible; e.g. "desk top" procedures. Of course, if more detailed modeling studies have been previously carried out on the receiving water, these should be used. Some preliminary assessment methodologies are described by MOE (1980a) and EPA (1976). For example, Hamilton (in MOE, 1980a) describes a simplified graphical procedure for determining the assimilation capacity of rivers and streams. Some of the more advanced modelling procedures are outlined later in Chapter 6. Hydrologic and water quality data (Sections 5.2.3 and 5.2.4) are generally available for many Ontario receiving waters whereas biological data are more limited and tend to be of a qualitative nature.

The nature and magnitude of the pollutant sources (BOD_5, SS, nutrients, bacteriological or other substances) and their seasonal (wet or dry season) variations will influence the type of receiving water analysis utilized. For example, certain PCP situations may require focusing on long term effects, such as toxics accumulation, whereas others may only need short-term analyses (BOD_5, DO). In addition, the nature of the receiving water (lake versus stream, embayment versus coastal area, circulation patterns, etc.) will govern the type of analysis. In general, for the cursory assessment, a steady state mathematical model will be suitable for the receiving water analysis. Dissolved oxygen, bacteria, temperature and nutrient phenomena have all been modelled using steady state procedures.

5.2.10.1 Streams

A preliminary evaluation of cause and effect relationships in the receiving stream can usually be made by plotting average water quality with respect to pollutant sources. An example of this type of analyses is shown in Figure 5-4. The effects and relative importance of pollutant sources (e.g. CSO bacterial effects and industrial DO effects) in Figure 5-4 are quite often indicated by this type of analysis. However, the analyst should be cognizant of dispersion and reaction factors that may influence instream concentrations. For this reason, modelling approaches using graphical or mass balance steady-state techniques are recommended as a follow-up step.

Seasonal effects (dry or wet weather) can be estimated for various pollutant sources by selection of the appropriate stream flow values. In Ontario for dry weather conditions a stream flow value, 7Q20 (average flow calculated from a 7 day averaging period and a recurrence interval of 20 years) is generally used. If the 7Q20 = 0 then a shorter recurrence interval should be employed (e.g. 7Q5). The pollutants that are usually of interest in cursory stream analysis include, phosphorus, dissolved oxygen, ammonia, chlorine, heavy metals and bacteria. These pollutants can be grouped into one of three categories: conservative (heavy metals), single reactant (bacteria) and coupled sequential reactants (dissolved oxygen).

Conservative Substances

Conservative substances are those that are not subject to reactive change. The appropriate simplified dilution equation for predicting instream concentrations for point and distributed sources is shown in Table 5-6. For details on application of the equation refer to EPA (1976). Conservative substance analyses are usually carried out for low flow (7Q20) conditions.

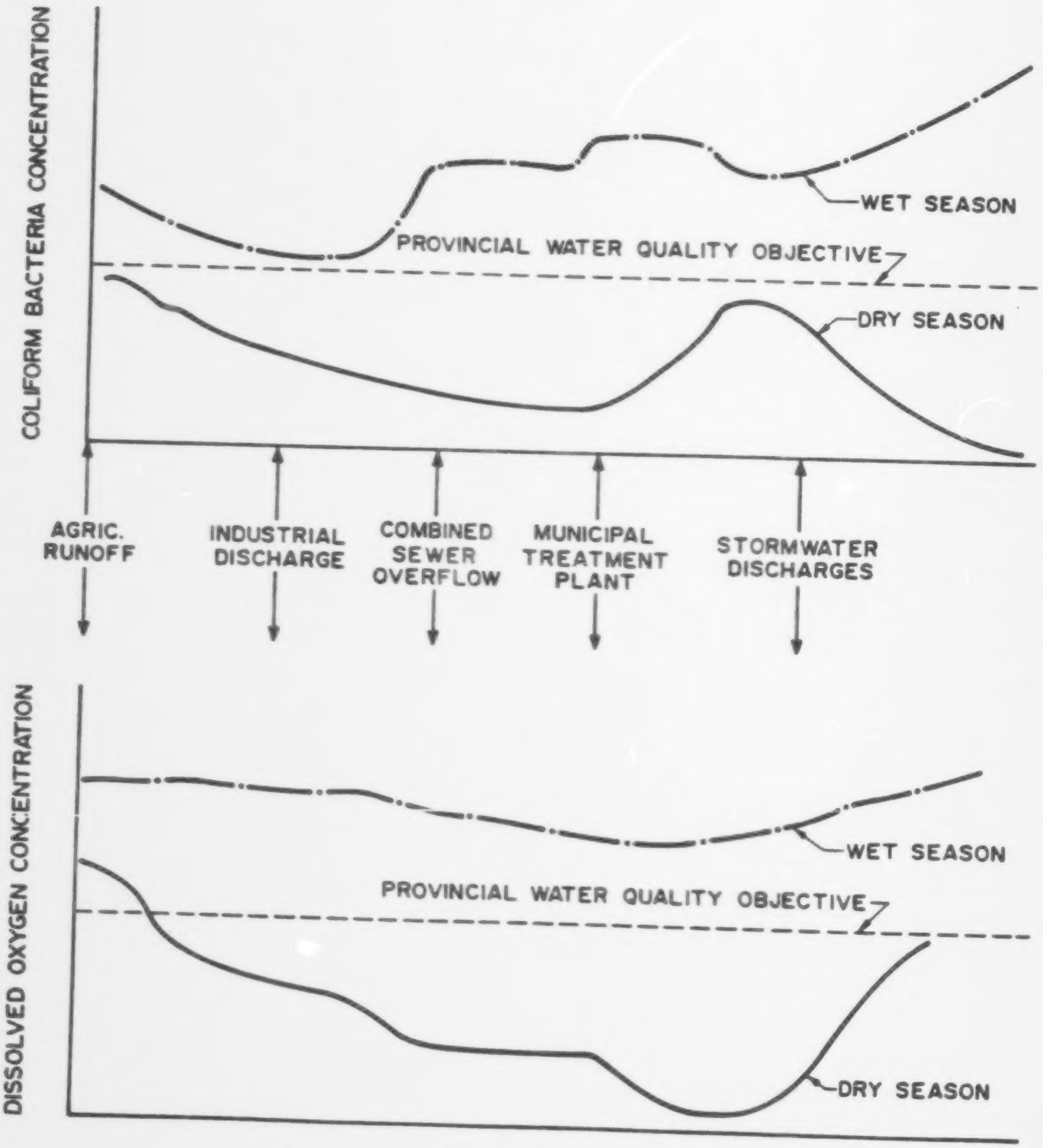
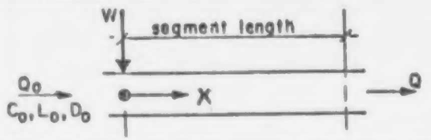
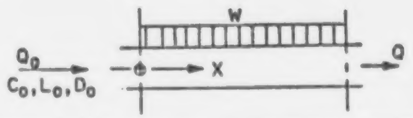


FIGURE 5-4 - WET AND DRY SEASON COLIFORM AND DISSOLVED OXYGEN DATA FOR HYPOTHETICAL PCP AREA

TABLE 5-6. SUMMARY OF SIMPLIFIED EQUATIONS FOR PREDICTING IN-STREAM POLLUTANT CONCENTRATIONS

	POINT SOURCE	DISTRIBUTED SOURCE
		
Conservative C	$C = C_0 + W/Q$	$C = C_0 + wX/Q$
Reactive L	$L = L_0 e^{-K_r X/U} + (W/Q) e^{-K_r X/U}$	$L = L_0 e^{-K_r X/U} + \frac{w}{A.K_r} (1 - e^{-K_r X/U})$
Coupled D	$D = D_0 e^{-K_a X/U}$ $+ L_0 \cdot \frac{K_d}{K_a - K_r} (e^{-K_r X/U} - e^{-K_a X/U})$ $+ (W/Q) \cdot \frac{K_d}{K_a - K_r} (e^{-K_r X/U} - e^{-K_a X/U})$	$D = D_0 e^{-K_a X/U}$ $+ L_0 \cdot \frac{K_d}{K_a - K_r} \cdot (e^{-K_r X/U} - e^{-K_a X/U})$ $+ \frac{w}{AK_r} \cdot \frac{K_d}{K_a - K_r} (\frac{K_r}{K_a} e^{-K_a X/U} - e^{-K_r X/U} + \frac{K_a - K_r}{K_a})$

NOTE,

Q = FLOW
X = DISTANCE
C = CONSERVATIVE SUBSTANCE CONCENTRATION
L = REACTIVE SUBSTANCE CONCENTRATION (BOD)
D = COUPLED SUBSTANCE CONCENTRATION (D.O. DEFICIT)
U = VELOCITY
A = CROSS-SECTIONAL AREA

K_r = BOD REMOVAL COEFFICIENT
K_d = BOD OXIDATION COEFFICIENT
K_a = D.O. REAERATION COEFFICIENT
C_0, L_0, D_0 = CONCENTRATION AT X = 0
W = POINT SOURCE LOADING RATE
w = NON-POINT SOURCE LOADING RATE

Reactive Substances

Substances such as BOD_5, bacteria, and nutrients can change within the receiving water due to physical, chemical and biological reactions. For example, nitrogen and phosphorus are subject to plant and algae uptake during summer periods. The reactive substance equation is shown in generalized form in Table 5-6. The critical parameter in the equation is the reaction rate coefficient (k_r) relevant to the pollutant being modelled. Typical values (per day) are, coliform bacteria (1-3), BOD_5, (0.2-2.0) and nutrients (0.1 to 1.0). For specific detail on selection and utilization of k_r, refer to MOE (1980a) and Hydroscience (1971). Bacterial analyses are generally carried out for wet weather conditions whereas BOD_5 and nutrients analyses are more appropriate for dry weather. From a toxicity standpoint, the portion of ammonia in the un-ionized form should be calculated from total ammonia concentration and pH data.

An example of the application of BOD_5 - DO modelling using the steady-state approach is shown in Figure 5-5 under dry weather conditions. Due to the incremental nature of the model used, it was possible to separate the impacts of separate pollutant loads (e.g. treatment plants, combined sewer overflows and non point run-off). In the example, municipal and industrial point sources and combined sewer overflows are contributing significantly to the predicted dissolved oxygen deficit.

5.2.10.2 Lakes

Procedures for estimating the impact of pollutant sources on lakes are not as straightforward as stream assessment procedures. Generally the assessment will involve whole lake, nutrient enrichment (eutrophication) or toxic material accumulation evaluations or localized evaluations in the vicinity of pollutant discharges. Aspects of the latter are discussed in the subsequent section on mixing zones.

The relatively simple models developed by Vollenweider (1976) and Dillon and Rigler (1974) address long-term eutrophication effects and relate lake nutrient loading (nitrogen and/or phosphorus) to lake morphometry and hydraulic budget information. Chapra (1979) has recently developed a variation of this approach which can be applied to embayment areas of large lakes.

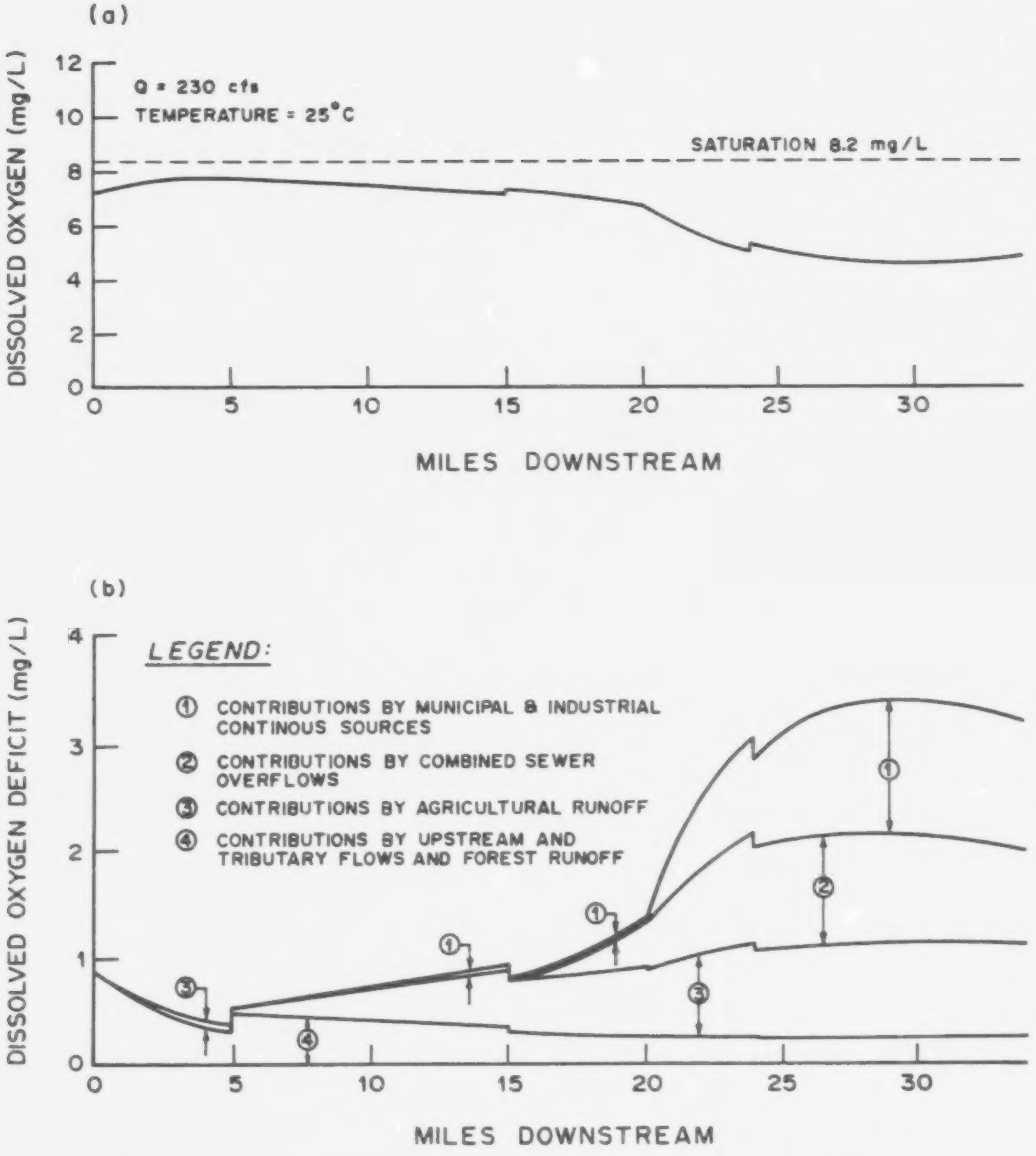


FIGURE 5-5 — COMPUTED ESTIMATES OF DISSOLVED OXYGEN DISTRIBUTIONS (SUMMER AVG. FLOW) AND COMPONENT D.O. DEFICIT DISTRIBUTIONS HYPOTHETICAL EXAMPLE

Application of the Vollenweider (1976) model requires calculation of annual nitrogen and phosphorus loadings to the lake, determining the lake hydraulic residence time and hydraulic loading rate and determining whether nitrogen or phosphorus loadings are excessive or permissible by comparing to critical loading plots. See example shown in Figure 5-6. Most of the requisite data for this type of analysis are readily available for Ontario lakes or can be derived from land use areal loadings and simplified water balances.

Chapra (1980) has developed a relatively simple model which is capable of predicting several eutrophication processes including phosphorus, chlorophyll (as algae indicator) and dissolved oxygen. The model also includes a waste source estimation subroutine. As with the Vollenweider model, the Chapra model is suitable for projecting long term effects.

5.2.10.3 Mixing Zones

In larger lakes (e.g. Great Lakes) or instream areas immediately downstream of a pollutant discharge it is often necessary to predict the localized concentrations of pollutants (e.g. toxic metal, chlorine, ammonia, etc). The "Blue Book" also provides for a mixing zone and a zone of passage in the vicinity of an outfall in a receiving water body to accommodate the conflicting needs of effluent discharge and habitat requirements of aquatic biota. It may be necessary during the cursory assessment to estimate the extent of the mixing zone and determine if a zone of passage exists for specific point source pollutant sources. Gowda (1981) describes field survey and prediction procedures for predicting mixing zones below bank outfalls in shallow rivers. The procedure has been evaluated for prediction of residual chlorine downstream of a treatment plant outfall. Kohli (1981) and Hamdy (1981) outline simple graphical and analytical procedures for predicting surface dilutions of pollutants discharged into near shore regions of large lakes.

5.2.10.4 Output of Receiving Water Analysis

The anticipated result of the receiving water analysis can be generalized to a comparison of present and projected future water quality conditions to the Provincial Water Quality Objectives (PWQO) and determining an appropriate course of action. This process is depicted in its simplest form below:

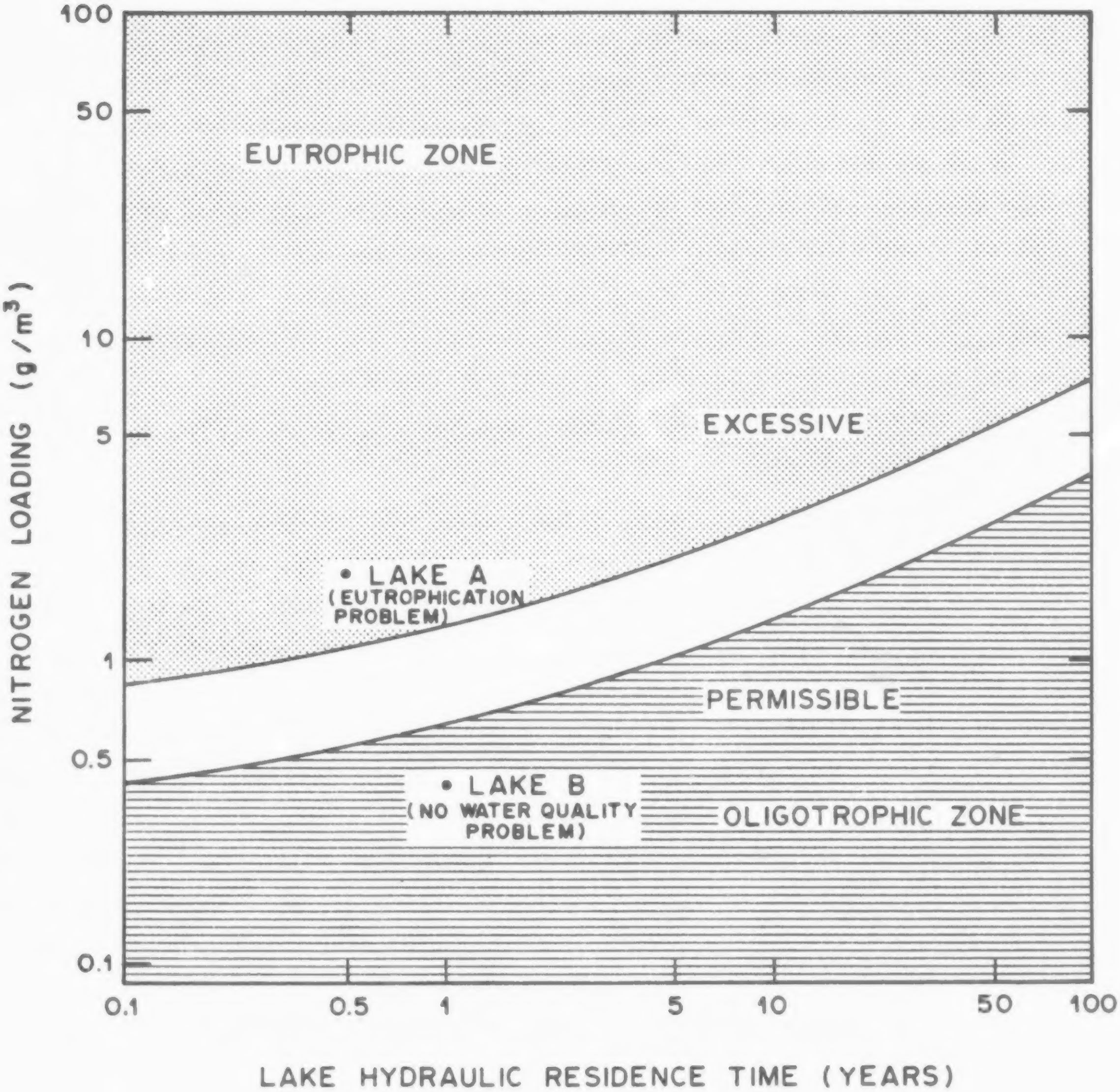


FIGURE 5-6 — CRITICAL NITROGEN LOADING PLOT FOR LAKES (VOLLENWEIDER, 1976)

WATER QUALITY CONDITION	WORSE THAN PWQO	BETTER THAN PWQO	UNKNOWN
Present	Controls needed	Reserve capacity available	Additional data collection and analysis if warranted
Future	Future controls needed	Reserve capacity available	

In a situation where water quality is better than the PWQO and reserve assimilation capacity is available, any decision as to whether this capacity can be utilized in the future or whether existing conditions must be maintained will be made in conjunction with MOE.

5.2.11 Facilities Analysis

As shown in Figure 5-1, a facilities analysis is an integral part of the cursory assessment. This analysis serves to integrate municipal services planning and operation with water quality management. Facilities analyses are necessary to:

(1) assess the hydraulic adequacy of sanitary and stormwater collection and treatment facilities under present and future land use conditions;

(2) identify potential structural and non-structural treatment and collection system upgrading or expansion alternatives;

(3) review treatment and collection system operation and maintenance practices to identify, where possible, more cost-effective practices;

(4) identify and document other storm, combined, and sanitary sewer problems (e.g. excessive infiltration and inflow (I/I), basement flooding surcharging, bypassing etc).

All wastewater treatment plants, stormwater or combined sewer overflow treatment facilities, sanitary and storm drainage collection and pumping facilities and combined sewer regulators and relief structures within a PCP area will be subject to a facilities analysis.

5.2.11.1 Wastewater Treatment Plants

A check list of the items to be included in the wastewater treatment plant analysis is summarized in Table 5-7.

TABLE 5-7. CHECKLIST OF ITEMS TO BE INCLUDED IN WASTEWATER TREATMENT PLANT ANALYSIS

- Review of Operation Practices
- Summarize operating costs
- Performance Evaluation (liquid and sludge streams)
- Unit Process Evaluations (hydraulic and/or organic loading and capacity)
- Bypass Assessment [type (raw, or primary sewage), frequency, volume, concentrations, etc.]
- Identification of Operational Problems
- Validation of Monitoring Data (flow, quality parameters) (sludge and liquid)
- Summarize Chemical Usage (chlorine, P-removal, precipitant, etc.)
- Energy Audit

The Total Utility Monitoring and Management Information System (TUMMIS) (MOE, 1982), when fully developed by MOE, will be one of the major information sources for the treatment plant analysis. Most aspects of the TUMMIS concept; i.e. (1) stream quality objectives, (2)loading allocations, (3) plant performance requirements, (4) actual plant performance, (5) remedial program identification, and (6) program evaluation are directly integratable with the PCP process. At the present stage, only modules 3, 4 and 5 are developed and operational.

The need for expanding/upgrading the treatment facilities can be determined by comparing existing plant facilities and operation to relevant MOE policies (see Chapter 3) i.e.

(1) Draft policy governing the Need for Expansion and/or Upgrading for Municipal and Private Sewage Treatment Works".

(2) "Guidelines for Sampling and Analysis Requirements for Municipal and Private Sewage Treatment Works" (Liquid Waste Streams) MOE Policy 08-06.

(3) Supporting guidelines (A, B, C) for MOE Policy 08-01 "Levels of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters".

Many municipalities may have carried out treatment plant analyses under the requirements of the above policies. If this is the case, these can be incorporated into the PCP process. On the other hand, if no facilities analyses have been done then they should be initiated as part of the PCP. Further detail on the specifics of plant evaluation is provided by EPA (1978b) and EPA (1979).

5.2.11.2 Combined Sewers

A schematic illustrating typical features of a combined sewer system is shown in Figure 5-7.

Aspects that should be incorporated into the combined sewer analysis are summarized below:

(1) location and receiving water body for all combined sewer overflows;
(2) combined sewer flow transmission capacities versus present and expected future peak dry weather flow rates;
(3) location, physical description, flow transmission, hydraulic capacity and overflow hydraulic capacity of all regulators and cross-connections;
(4) combined sewer cleaning programs;
(5) regulator and cross-connection inspection and maintenance programs;
(6) the estimated pollutant loading (concentrations) for critical water quality characteristics which would occur during peak dry weather flows and during wet weather flows; and
(7) the estimated impact which such loadings would have on the receiving water body.

The latter two points are also an integral part of the pollutant source receiving water analysis phase of the PCP process.

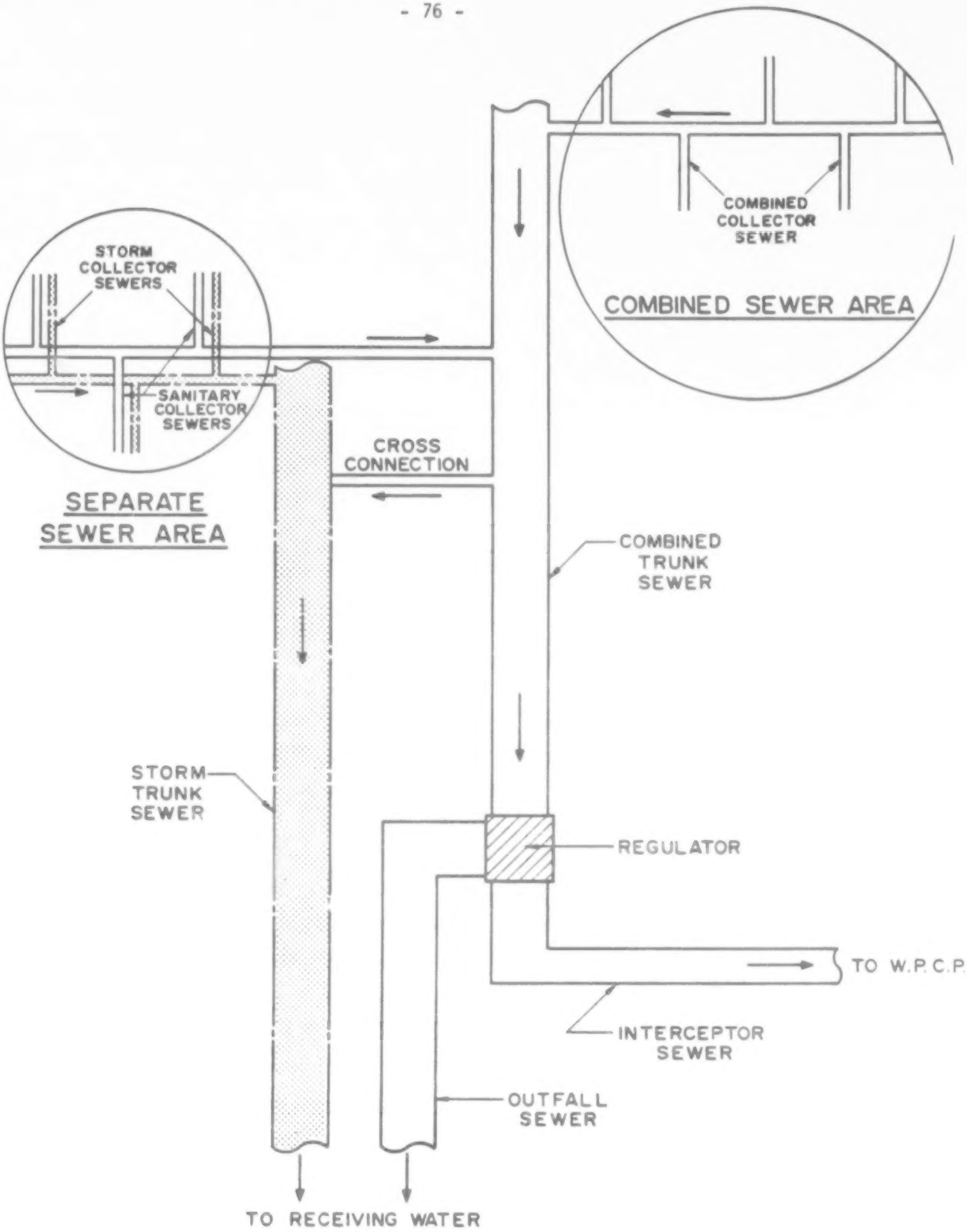

COMBINED COLLECTOR SEWER
COMBINED SEWER AREA
STORM COLLECTOR SEWERS
SANITARY COLLECTOR SEWERS
SEPARATE SEWER AREA
CROSS CONNECTION
COMBINED TRUNK SEWER
STORM TRUNK SEWER
REGULATOR
TO W.P.C.P.
INTERCEPTOR SEWER
OUTFALL SEWER
TO RECEIVING WATER

FIGURE 5-7 — SCHEMATIC OF PARTIALLY COMBINED SEWER SYSTEM

5.2.11.3 Sanitary and Storm Sewer Collection Pumping Facilities

The sanitary and storm sewer collection and pumping facilities should be subjected to an analysis similar to the combined sewer analysis. Specific items to be included in this analysis are:

(1) description of facilities;
(2) evaluation of present and future hydraulic capacity;
(3) identification of reserve capacity;
(4) documentation of operating problems (bypasses, basement flooding, etc.); and
(5) energy audit.

5.2.12 Infiltration/Inflow Analysis

One of the objectives of the cursory assessment is to assess the magnitude of the infiltration/inflow (I/I) problems in the existing sewer systems of the PCP area. Excessive I/I can produce adverse inputs such as impairment of wastewater treatment processes, sustained wastewater bypassing, flooding (depending on duration), and increased operating costs. Consequently, the I/I analysis can be directed at one or more of; (1) wastewater treatment facilities, (2) wastewater collection and pumping facilities, and (3) combined sewer overflow facilities.

The magnitude and persistence of I/I flows are in part related to season. During the spring freshet period, I/I flows can be the result of snowmelt. Such effects are difficult to analyze and will require specialized techniques. During the summer/fall period I/I flows are generally associated with precipitation events and can be broken down into; (1) dry weather infiltration (sustained elevation of base flows), (2) wet weather infiltration (short duration producing major flow increases), and (3) inflow (direct stormwater runoff input into sewer system).

An I/I analysis can generally be carried out at two levels of detail; i.e. (1) a preliminary I/I analysis and (2) systematic evaluation of the sewer system to locate all significant sources of I/I, quantify these and estimate rehabilation costs. The preliminary I/I analyses is considered to part of the cursory assessment whereas further evaluation generally becomes part of the detailed assessment (Chapter 6).

The key considerations for a preliminary I/I are itemized in Table 5-8. For most municipalities, this information can be compiled from existing sources. In addition, much of the data will have been compiled in other stages of the PCP process. Major emphasis should be placed on the treatment plant and the effects of I/I on treatment, degree of bypassing and the magnitude of basement flooding. The I/I analyses should also be split into wet and dry season components.

TABLE 5-8. CONSIDERATIONS FOR A PRELIMINARY INFILTRATION/INFLOW ANALYSIS

PREPARE SEWER SYSTEM MAPS

- sanitary and combined sewers
- size of sewers and direction of flow
- location of treatment facilities, pumping stations, (flow measurement manholes, bypasses and river crossings)
- relative locations of storm sewers (e.g. same trench)

COMPILE RELATED DATA

- PCP area topography
- soils types and distribution
- groundwater depth and distribution
- rainfall
- water consumption (per capita & industrial)
- popluation
- wastewater flows

In Stratford the following steps were employed for the preliminary assessment of I/I:

(1) Sewer system was broken down into sub catchments;
(2) Water consumption, population and land use data were compiled for each sub catchment;
(3) A baseline or theoretical wastewater production rate was calculated for each sub catchment; and
(4) Comparison of monitoring data from sewer location and wastewater treatment plants to theoretical wastewater production rates allowed an assessment of I/I to be made.

An example of the dry weather infiltration in the sanitary sewers of Stratford is shown in Table 5-9. It is apparent that John Street and West Gore catchments are major contributors to the dry weather infiltration problem.

5.3 Formulation and Evaluation of Pollution Control Plans

Certain control alternatives will be identified during the inventory and analysis stage of the cursory assessment, particularly from the facilities analysis component. Other alternatives for control of point (continuous and intermittent) and non-point sources are reviewed in Chapter 7. Establishment of evaluation criteria and procedures for preliminary screening and evaluation of alternatives plans are discussed in Chapter 8. For further detail on this aspect of the cursory assessment reference should be made to Chapter 8.

5.4 Output from the Cursory Assessment

The outputs that can be anticipated from the cursory assessment will include:

(1) A comparison of receiving water quality under present and future pollutant source condition to PWQO's (Section 5.2.9.4) to determine the severity of water quality problem.

(2) Analysis of the significant wastewater facilities in the PCP area and preliminary identification of upgrading/expansion alternatives.

(3) Determination of the severity of I/I problems.

(4) Preliminary analyses of control alternatives and, in some cases, selection of management plan for pollution control (i.e. a PCP).

(5) Recommendation of interim pollution control measures to be put into effect while detailed assessments are being carried out.

(6) Identification of areas requiring detailed assessment (data needs and proposed analysis techniques).

(7) Revised terms of reference for the PCP studies including revised objectives and problem statement, additional resources, new (if any) administrative arrangements, new participating parties (if any), revised timetable.

TABLE 5-9. SANITARY DRY WEATHER INFILTRATION (Greck et al, 1982)

		OBSERVED FLOWS		THEORETICAL PRODUCTION RATE		DRY WEATHER INFILTRATION		INFILTRATION(2) AS % OF CITY TOTAL
	CATCHMENTS	DAILY AVG. (m^3/day)	DAILY AVG. PER CAPITA (Lpcd)	DAILY AVG. (m^3/day)	DAILY AVG. PER CAPITA (Lpcd)	DAILY AVG. (m^3/day)	DAILY AVG. PER CAPITA (Lpcd)	
North Shore (24 inches)	1	1,640	377	903	207	737	169	8.5
John Street	2 (1)	3,501	1,263	594	214	2,907	1,049	34
Cemetery (24 inches)	3	863	497	319	184	544	313	6
West Gore (30 inches)	4	5,379	1,697	1,958	618	3,421	1,079	39.5
Erie & Area 6 (12 & 24 inches)	5 + 6 (1)	4,408	417	4,461	422	0	0	0
Peter (36 inches)	7	2,291	629	1,249	343	1,042	286	12
TOTAL CITY	1 to 7	18,082	689	9,484	361	8,651	328	100

1 = Flows have been computed by subtraction

2 = Based upon a total dry weather infiltraton of 8,651 m^3/day

A hypothetical example of the output from a cursory assessment for a hypothetical PCP area (Figure 5-2) is presented in Table 5-10.

The "First Phase" of the Avon River Study (MOE, 1979) is perhaps the best "Ontario" example of a cursory assessment. The study provided a basis for determining the type of abatement measures required to improve water quality in considering all significant discharges to the River. The main municipality involved was the City of Stratford. Analyses of water quality data (receiving water and pollutant sources) showed that PWQO's were violated periodically for dissolved oxygen, zinc, chlorine residual, phosphorus, ammonia and chromium. These violations were due to a combination of municipal, agricultural and industrial discharges. [The Avon River Study, including a detailed assessment stage, was completed in 1983 (MOE, 1984).]

TABLE 5-10. CURSORY ASSESSMENT OF WATER QUALITY PROBLEMS IN A HYPOTHETICAL PCP AREA

(a) Pollutant Source-Receiving Water Analysis

SOURCE	DISSOLVED OXYGEN	PUBLIC HEALTH	EUTROPHICATION	SUSPENDED SOLIDS	OTHER
Point Sources (a) Treatment Plant	Slight downstream DO depletion	Excessive wet weather coliform levels during bypassing	Contributing 15% of total P load to lake P	No significant effect	Residual chlorine and ammonia toxic to fish downstream
(b) Industrial	No effect	Heavy metal levels over drinking water objectives	No effect	No effect	Contributing significant levels of zinc and nickel to river
Storm sewers	No significant effect	Wet season coliform problem	Contributing 5% of total P load to lake	Sediment accumulation in lake bottom	Periodically high metal levels due to industrial connections
Combined sewer overflows	Severe wet season DO depletion	Wet season coliform problem	-	Sediment accumulation at outfall	-
Forested runoff	No effect	No effect	No effect	No effect	-
Agricultural runoff	No significant effect	Periodic wet weather coliform problem due to pasture runoff	Contributing 80% of total P load to lake eutrophication	No significant effect	High pesticide levels in lake sediment
Other (a) Feedlot	Wet season DO depletion in tributary	Wet season coliform problem	No significant effect	No significant effect	-
(b) Quarry	No effect	No effect	No effect	Creating year round turbidity problem in lake	-
(c) Thermal	Indirect effect during low flow	No effect	No effect	-	Excessive temperature rise in stream during low flow

(b) Facilities Analysis

- Improvement in wastewater treatment plant operations (high SS in effluent) upgrading alternatives include filtration and additional P-removal.
- Excessive bypassing of treatment plant during wet weather.
- I/I excessive in one older section of sanitary sewer system.
- Combined sewer regulators need repair.

(c) Interim Controls

- Rehabilitate sewers with high I/I.
- Freeze on further sewer hook-ups until P-removal in place.
- Enforce industrial sewer by law to lower metal discharges

(d) Recommendations for Detailed Assessment

- Investigate biological effects of pesticide accumulation in lake.
- Investigate effects of metal discharges on receiving stream.
- Monitor industrial discharges.
- Evaluate Best Management Practices (BMP's) for controlling phosphorus discharge from agricultural areas.

CHAPTER 6

DETAILED ASSESSMENT PROCEDURES

6.1 Introduction

Detailed assessment procedures will become necessary if the cursory assessment does not adequately address certain critical aspects of the PCP development (See Figure 1-2). Specifically, detailed assessments may be required in one or more of the following areas:

(1) Application of a more sophisticated pollutant source model.
(2) Utilization of a more sophisticated receiving water quality model.
(3) Collection of additional site specific data
  - to define specific cause-effect relationships
  - to evaluate control alternatives
  - to assess a specific biological impact on the receiving water
  - pollutant source characterization (e.g. combined sewer overflows, treatment plant bypass flows, stormwater, non-point sources)
  - industrial (sanitary and storm sewer discharge) monitoring
  - receiving water characteristics to further define temporal or spatial variations, to calibrate a simulation model, or to quantify a particular water quality impact.
(4) Further analysis of infiltration/inflow problems in the sewer system.

It is important to point out that there is no distinct dividing line between cursory and detailed assessment stages of a PCP. Every PCP will be different and the nature of these assessments will be influenced by factors such as: (1) size of the planning area, (2) available resources, (3) severity or immediacy of pollution problems, and (4) required accuracy of water quality predictions. The latter factor is particularly applicable to determining the degree of sophistication necessary for pollutant source and receiving water quality models.

It is beyond the scope of this report to provided extensive background on detailed assessment procedures. However, some of the key considerations in each of these above areas will be highlighted in this Chapter. To illustrate the detailed assessment process, examples from the Grand River study will be used. An extensive amount of reference material relevant to these topics is available. For further details refer to EPA (1976) and COA (1980a).

6.2 Collection of Additional Data

Due to the site-specific nature of the process, it is difficult to establish overall guidelines for the collection of any additional data which may be required by the PCP process. In general, the collection of additional data will become necessary when the existing data base precludes adequate definition of the causes and effects of significant pollutant discharges in a planning area or when the effectiveness of certain control alternatives is unknown and must be evaluated.

6.2.1 Pollutant Sources

If the cursory assessment indicates that certain point or non-point sources, for which there are little or no monitoring data, may be exerting significant water quality impacts, then these sources should be characterized.

For point source municipal and industrial discharges, monitoring procedures will be straightforward and will involve collection of flow proportioned samples over several representative time periods. If significant flow variation is anticipated, then discrete sampling (e.g. 1-2 hr frequency) should be carried out. The samples should be characterized for any pollutants that are expected to have a receiving water impact. Typically, parameters could include BOD_5, nitrogen species, phosphorus, solids, heavy metals, alkalinity, pH, bacteria and certain trace organics. The flow and concentration data can then be combined to compile mass loadings for each source. Alternatively, the discrete sample data may be analysed to delineate temporal variations. For further detail on monitoring and sampling procedures for point sources refer to Dyer et al (1981). For an example of this type of data collection, for an Ontario situation, refer to the recent Stratford studies (MOE, 1984).

As noted in chapter 5, combined sewer overflows, treatment plant bypasses and stormwater sources are more difficult to characterize than point sources due to their intermittent nature. Marsalek (1976) provides an in-depth description of the equipment requirements and sampling techniques required to obtain representative data for intermittent sources. Several stormwater monitoring projects carried out in Ontario, i.e. Burlington (Marsalek, 1977), Brucewood site (J.F. MacLaren Ltd., 1980), East York (Mills, 1977), Toronto, (M.M. Dillon, 1979) and Hamilton (Gore & Storrie Ltd., 1980) illustrate the application of these techniques.

In many instances, industrial discharges to the sanitary or storm sewer systems may be contributing certain pollutants to the receiving water. A listing of selected industries and potential pollutants from these industries is presented in Chapter 7 (Table 7-1). Once a detailed inventory of the industries in the PCP area has been developed (part of the cursory assessment), then a comparison can be made between pollutant source and receiving water quality data to indicate potential industrial contributors. If specific industries are suspected of contributing significant levels of certain pollutants, and little or no monitoring data exists to document this, then additional sampling and characterization should be carried out. Procedures for monitoring industrial effluents are described in detail by Dyer et al (1981). An industrial survey for the City of Stratford is described in a recent MOE report (MOE, 1984).

6.2.2 Receiving Water Characteristics

Additional data requirements for receiving waters usually fit into one of two categories:

(1) Collection of information on receiving water pollutant levels to determine if receiving water quality meets, exceeds or violates relevant water quality objectives or in other words, determine if there is a water quality problem.

(2) Collection of information on receiving water to calibrate and/or verify a receiving water model or to better define the nature of specific receiving water components (e.g. photosynthesis or benthic oxygen demand).

The first category is rudimentary to the PCP process and in many instances, existing data sources will be sufficient. However, site specific circumstances may dictate additional sampling. For example, it may be necessary to determine the levels of trace organics downstream of a chemical manufacturing plant.

The type of model selected for receiving water quality predictions will dictate the nature and magnitude of data collection for the second category. Care must be taken not to select a model which is overly sophisticated or complex for the situation, so that an unwarranted amount of data is required in order to run the model.

Dissolved oxygen or nutrient models for streams and lakes may commonly require additional information in one or more of the following areas:

(1) reaeration or degradation coefficients;
(2) photosynthetic and respiration effects of rooted plants and algae;
(3) oxygen demand characteristics of bottom deposits;
(4) oxygen demand of certain chemical species (sulphides, ferrous iron etc.) in pollutant discharges;
(5) nitrogeneous (ammonia and organics) oxygen demands;
(6) sedimentation effects;
(7) mixing properties or hydraulic characteristics (time of travel, dispersion coefficients, thermal stratification) and;
(8) magnitude of diurnal or seasonal water quality fluctuations.

It is beyond the scope of this report to provide extensive detail on receiving water monitoring procedures. For further specifics, reference should be made to MOE (1980a), Kittrell (1969), EPA (1976), and COA (1980a) and Draper and Walker (1981).

6.3 Sewer System Evaluation

As part of the cursory assessment, a determination will have been made as to whether I/I in the sewer system is excessive or not. Obviously if the I/I is not excessive, then further evaluation would probably be unwarranted. However, if I/I appears to be excessive, then further sewer system evaluations may be necessary. A sewer system evaluation is considered to be a step beyond the preliminary I/I assessment and involves a systematic examination of the sewer system to locate all the I/I sources which were previously determined to be potentially excessive, determine the flow rate for each and estimate the rehabilitation costs.

The sewer system evaluation may include further physical surveys of the sewer system, rainfall simulations, preparatory cleaning of selected sewers depending on the site characteristics. For further details on sewer system evaluation refer to EPA (1975b).

6.4 Pollutant Source and Receiving Water Quality Models

There are innumerable models of varying complexity available for pollutant source and receiving water simulations. For example, Jennings and Yotsukura (1979) recently summarized over seventy such models available within the U.S. Geological Survey alone. As pointed out earlier, the selection of an appropriate model depends on several factors which will vary from one PCP to another. In the final analysis, a model is generally selected based on prior experience and a demonstrated prediction capability. In general, models will be selected to satisfy one or both of the following two objectives (1) to provide a method for linking a forcing function such as rainfall to an output such as runoff, combined sewer overflows, water quality, etc., or (2) to enable analyses of the probability of certain critical events, ie., floods, PWQO violations, etc. There has been a tendency to develop models which combine pollutant source and receiving water predictions.

A considerable number of steady-state and non-steady-state models have been developed in the past decade which can be applied to the PCP process. A summary of these is contained in Appendix B.

6.5 Example of Detailed Assessment

The recent water quality studies on the Grand River watershed in Ontario are an excellent example of a detailed assessment. In this section certain aspects of the project will be discussed in order to illustrate some key elements of the detailed assessment process. The Grand River Basin water Management Study was carried out in a period from 1977 to 1981. During this time the intent was to define the water management problems confronting the Grand River basin and to develop a viable set of alternative management plans. These plans were designed to meet the following objectives:

1) reduce flood damages
2) provide adequate water supply
3) maintain adequate water quality

For purposes of highlighting a PCP detailed assessment the analysis techniques specific to the meeting the last objective are the most relevant. Discussion in the remainder of this chapter will centre on these techniques.

The principal water quality problem in the Grand River is the low levels of dissolved oxygen which occur during the critical summer period in the central Grand River between Kitchener and Glen Morris and in the Speed River downstream from Guelph. This is caused by organic waste discharges and nutrient inputs from six municipal sewage treatment plants and by upstream rural non-point sources. While water management problems are often the most apparent in the middle portion of the basin, flooding, water shortages and water quality impairment are encountered throughout the basin in rural as well as urban areas.

The model developed for the overall Grand River water quality assessment is referred to as the Grand River Simulation Model (GRSM) and is described in detail by Willson, et al (1981). The model evolved from earlier studies by MOE on the Thames River (MOE, 1975) and is capable of simulating up to 25 years of water quality data on a 2 hr time interval. Parameters that can be simulated include DO, temperature, total phosphorus, total nitrogen, ammonia, BOD_5, nitrogenous BOD, suspended solids and daily plant growth for three species of phytoplankton (using a nutrient uptake and release submodel). A users manual for the model is available from the Water Resources Branch of MOE.

6.5.1 Model Input

A flow chart of the GRSM is shown in Figure 6-1. The model utilizes STORM (See Appendix B for a description) to analyze storm water data. Stream flow data are processed by several sub-models including HEC 5 (Appendix B) and plant growth inputs are via a model ECOL 1. Water quality, meteorological, reaction rate and boundary condition data are fed to the main model via separate data manipulation routines.

6.5.2 Model Application

The Grand River was split up into several reaches in order to apply the model. Sewage treatment plant discharges from the cities of Waterloo, Kitchener, Guelph, Hespeler, Preston, Paris, and Brantford were considered as

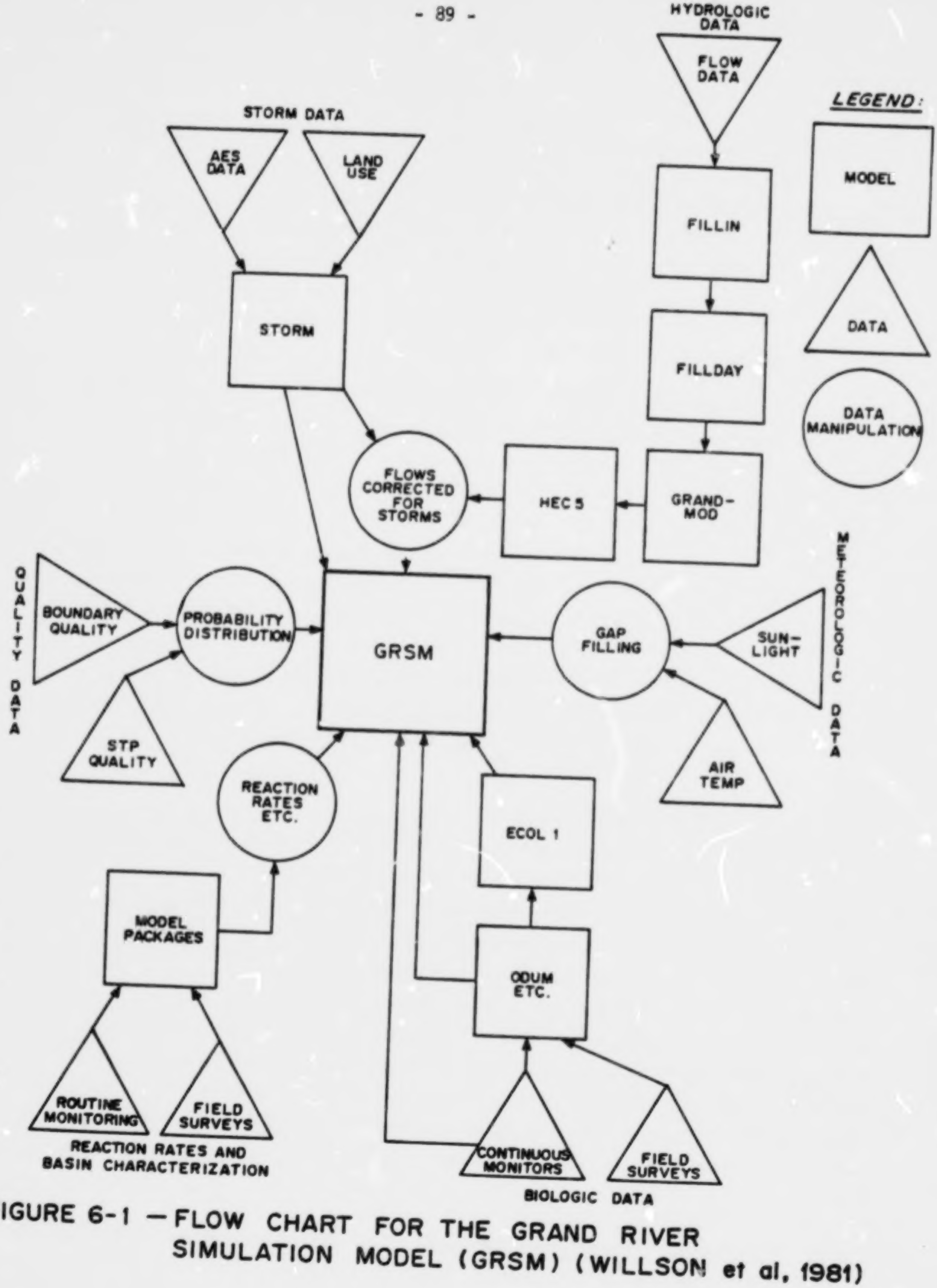

HYDROLOGIC DATA
FLOW DATA
LEGEND:
MODEL
DATA
DATA MANIPULATION
STORM DATA
AES DATA
LAND USE
FILLIN
STORM
FILLDAY
FLOWS CORRECTED FOR STORMS
HEC 5
GRAND-MOD
METEOROLOGIC DATA
QUALITY DATA
BOUNDARY QUALITY
PROBABILITY DISTRIBUTION
GRSM
GAP FILLING
SUN-LIGHT
STP QUALITY
REACTION RATES ETC.
AIR TEMP
ECOL 1
MODEL PACKAGES
ODUM ETC.
ROUTINE MONITORING
FIELD SURVEYS
REACTION RATES AND BASIN CHARACTERIZATION
CONTINUOUS MONITORS
FIELD SURVEYS
BIOLOGIC DATA

FIGURE 6-1 — FLOW CHART FOR THE GRAND RIVER SIMULATION MODEL (GRSM) (WILLSON et al, 1981)

point source continuous discharges. Urban runoff from Waterloo, Kitchener, Guelph, Cambridge and Brantford were considered as intermittent point sources. The reaches and waste sources are shown in Figure 6-2.

The model was calibrated with water quality data collected during 1976 at nine continuous monitoring stations on the river. The plant growth model ECOL 1 was calibrated for a reach which was phosphorus limited.

6.5.3 Model Output

The model is capable of several modes of output. Daily statistics (means, maximums, minimums) and monthly summaries can be calculated for any reach and for any of the simulated parameters. In addition, time series plots can be generated. An example of a time series output for the Speed River is shown in Figure 6-3a. Examples of daily DO simulation at specific locations under two flow regimes are shown in Figure 6-3b. Note the DO supersaturation that occurs due to plant photosynthesis during the day and the DO depletion that occurs at night because of plant respiration.

A feature of GRSM is that it is capable of computing probability distributions [e.g. can calculate for any given reach the % of time a particular water quality parameter is in violation of the relevant PWQO (MOE, 1978)]. This can be done in tabular form or via histograms.

6.5.4 Screening Alternatives

During the Grand River studies some unique screening procedures were utilized to assess the impacts of a large number of control alternatives. This screening procedure is shown in Figure 6-4. In essence, specific control options were initially simulated using a simple steady state DO model (DOMOD 7) coupled with the plant growth model (ECOL 1). If an alternative appeared to be viable at this stage it was then evaluated by the Public Working Group and a CORE Group before being selected as a final alternative or being rejected. Final alternatives then received further assessment via the GRSM. This approach realized considerable cost and time savings. For example a full computer run with GRSM involved about 0.5 hours of CPU time whereas the steady state runs with DOMOD 7 required only 0.5 sec. of CPU time.

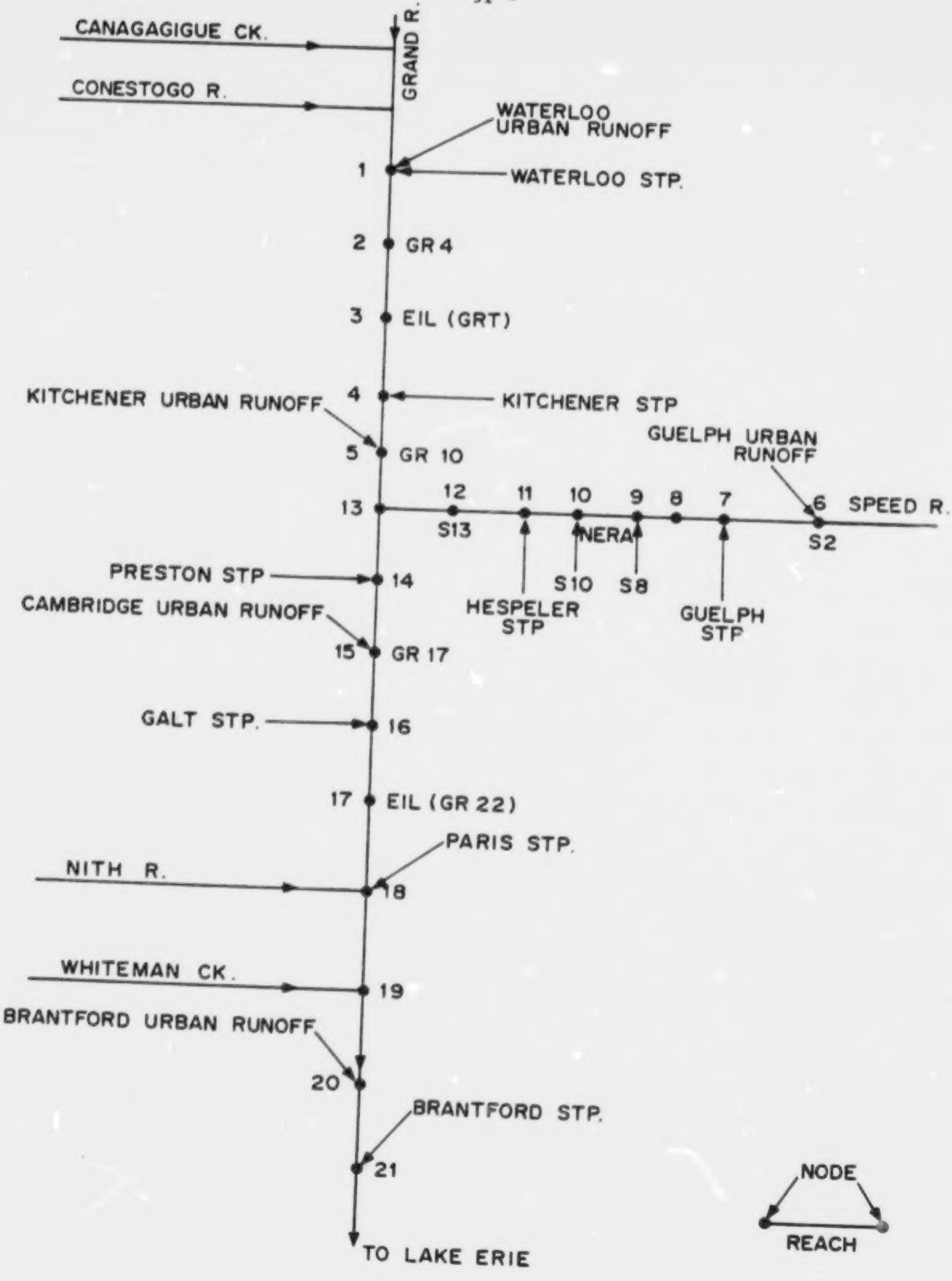
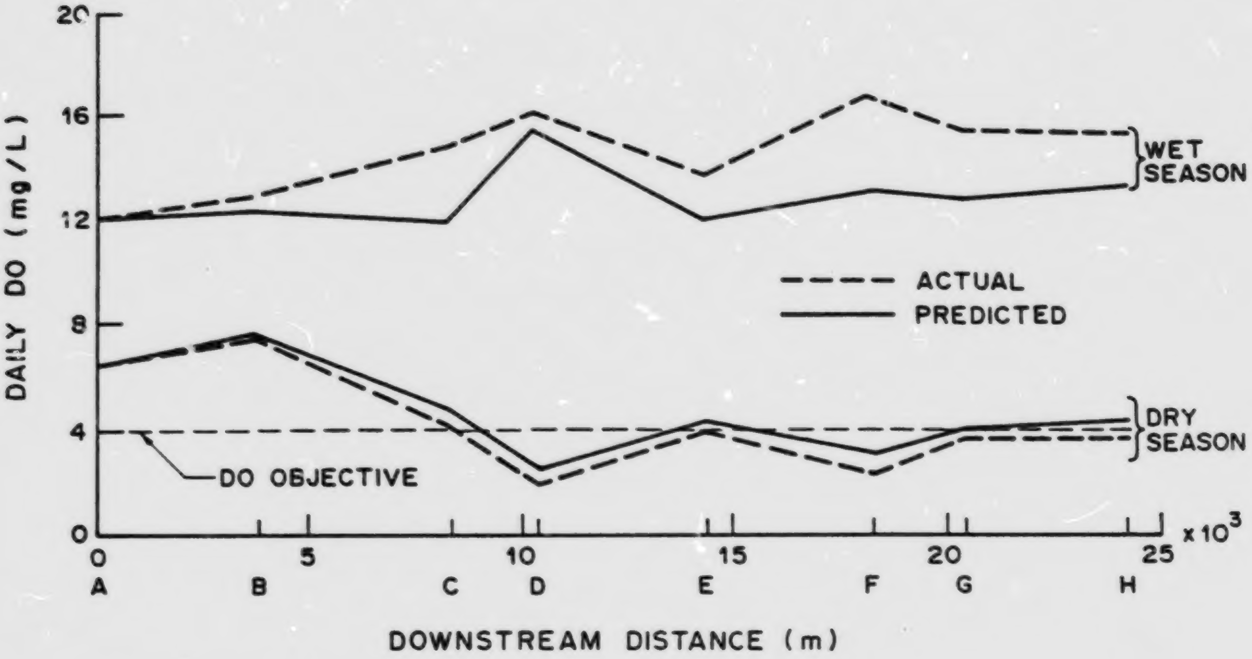
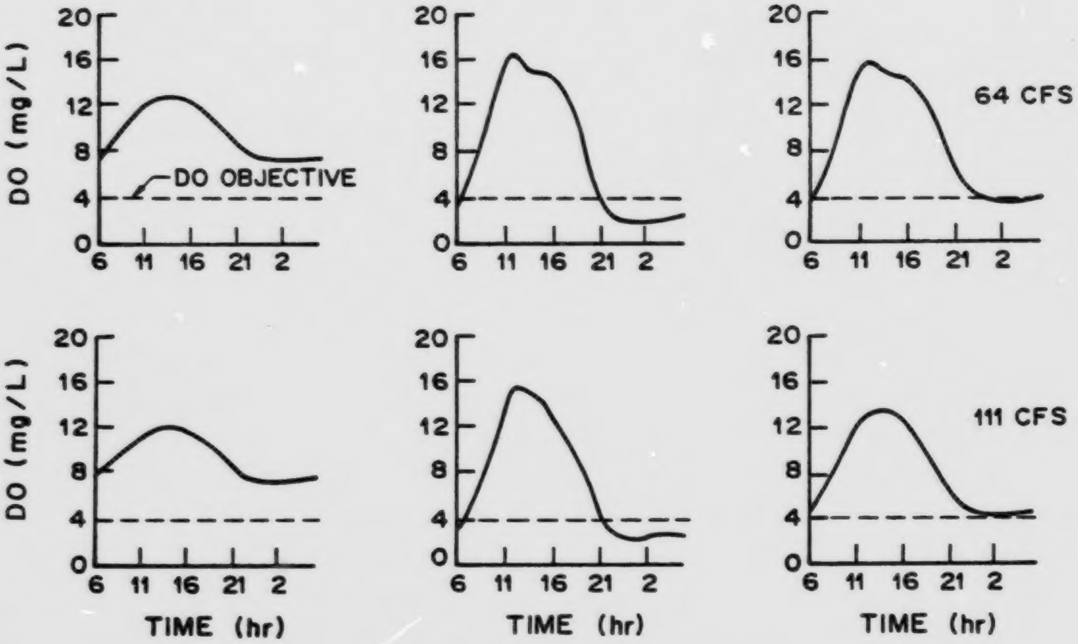

GRAND R.
CANAGAGIGUE CK.
CONESTOGO R.
WATERLOO URBAN RUNOFF
1
WATERLOO STP.
2
GR 4
3
EIL (GRT)
4
KITCHENER URBAN RUNOFF
KITCHENER STP
5
GR 10
GUELPH URBAN RUNOFF
13
12
11
10
9
8
7
6
SPEED R.
S13
NERA
S2
PRESTON STP
14
S10
S8
HESPELER STP
GUELPH STP
CAMBRIDGE URBAN RUNOFF
15
GR 17
GALT STP.
16
17
EIL (GR 22)
PARIS STP.
NITH R.
18
WHITEMAN CK.
19
BRANTFORD URBAN RUNOFF
20
BRANTFORD STP.
21
NODE
REACH
TO LAKE ERIE

FIGURE 6-2 — SEGMENTATION AND POLLUTANT SOURCES FOR THE GRAND RIVER (WILLSON et al, 1981)



(a) RIVER PROFILE



(b) DAILY VARIATION AT SPECIFIC STATIONS

FIGURE 6-3 — PROFILE AND DIURNAL DO PREDICTIONS FOR SPEED RIVER

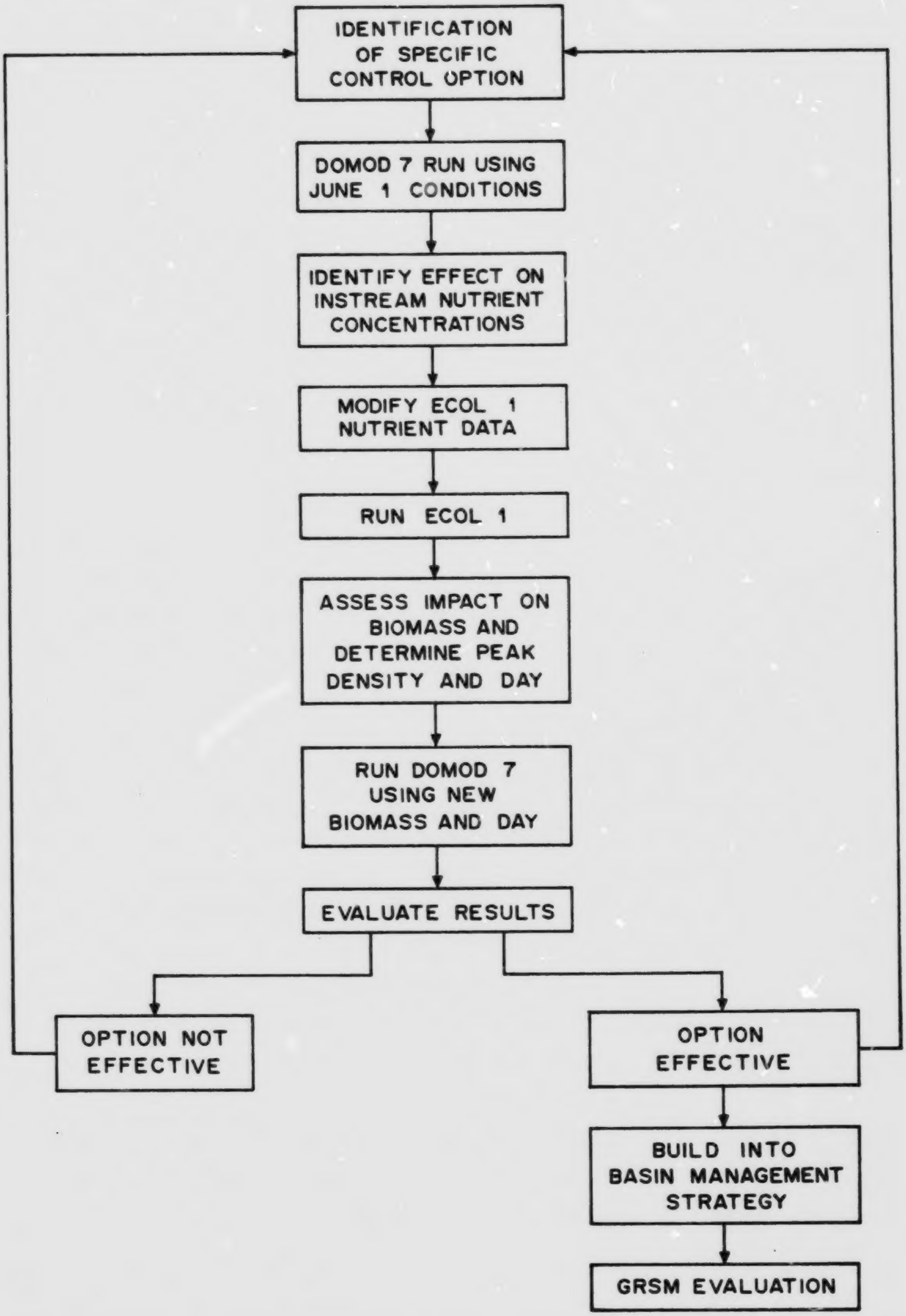

IDENTIFICATION OF SPECIFIC CONTROL OPTION
DOMOD 7 RUN USING JUNE 1 CONDITIONS
IDENTIFY EFFECT ON INSTREAM NUTRIENT CONCENTRATIONS
MODIFY ECOL 1 NUTRIENT DATA
RUN ECOL 1
ASSESS IMPACT ON BIOMASS AND DETERMINE PEAK DENSITY AND DAY
RUN DOMOD 7 USING NEW BIOMASS AND DAY
EVALUATE RESULTS
OPTION NOT EFFECTIVE
OPTION EFFECTIVE
BUILD INTO BASIN MANAGEMENT STRATEGY
GRSM EVALUATION

FIGURE 6-4 — SCREENING PROCEDURE USED IN GRAND RIVER STUDY (WILLSON et al, 1981)

CHAPTER 7

POLLUTION CONTROL ALTERNATIVES

7.1 General

A myriad of individual techniques exist for controlling point and non-point pollutant discharges from a PCP area. In general, these control alternatives fall into one of the following categories:

(1) point source (dry weather) controls;
(2) stormwater runoff and combined sewer overflow quality (wet weather) controls;
(3) stormwater runoff quantity (flooding and stream erosion) controls;
(4) non-point source controls.

Key aspects of various pollution control alternatives are highlighted in the following sections. For a specific PCP, it is recommended that a prescreening of alternatives be carried out to develop a "short-list" of applicable and feasible controls. This aspect can be integrated with the cursory assessment and, if used, is one of the inputs to the decision analysis step (Chapter 8).

7.2 Point Source Pollution Controls

Pollution control alternatives for industrial and municipal dry weather point sources include: industrial effluent controls; municipal treatment plant improvements; and receiving water modification. Each of these categories is briefly discussed below with literature references and Ontario examples cited wherever applicable.

7.2.1 Industrial Effluent Controls

7.2.1.1 "Blue Book" and Sewer Use Bylaw Enforcement

The "Blue Book" sets limitations on the quantities of specific pollutants that can be discharged from industries directly into receiving waters; i.e. discharge concentrations must be reduced to levels that do not impair the beneficial uses of receiving water.

At the local level, many Ontario municipalities have adopted sewer-use bylaws and industrial waste surcharge programs to ensure the protection of municipal sewage treatment facilities and to regulate the discharge of industrial waste to sanitary and storm sewers. Ontario has a "model" industrial sewer use bylaw. However, as noted by Atkins and Hawley (1978), municipalities are presently free to adjust the recommended Provincial model bylaw to suit local conditions. Atkins and Hawley (1978) surveyed 57 Ontario municipalities and found wide variations in allowable concentrations of specific substances, (particularly metals) from city to city. It was apparent that to achieve a stable and comparable influent to all sewage treatment plants in the Province, one of the options would be to adopt and enforce a uniform Province-wide bylaw.

Some municipalities have developed industrial waste surcharge formulas whereby an industry is charged for BOD and suspended solids (and occasionally other parameters) discharged at concentrations above the bylaw. An example of a sewer surcharge formula used by the Regional Municipality of Waterloo is given below:

$$\text{Surcharge } (¢) = Q \left[f_s \frac{(S_i - S_n)}{S_n} + f_p \frac{(P_i - P_n)}{P_n} \right] R_n$$

where Q = Quantity of sewage in 1000 Igal

f_s = Proportion of cost allocated to reducing suspended solids = 0.5

f_p = Proportion of cost allocated to reducing BOD_5 = 0.5

S_i = Suspended solids concentration (mg/L)

P_i = BOD_5 concentration (mg/L)

S_n = Bylaw limit on Suspended Solids

P_n = Bylaw limit BOD_5

R_n = Operating costs of sewage treatment plants in ¢/1000 Igal (varies from year to year and plant to plant within Region

A summary of surcharge formulae used by other Canadian municipalities has been compiled by Agriculture Canada and Environment Canada, (1979).

7.2.1.2 Pretreatment Upgrading

In order to meet Provincial or municipal discharge limits, or to reduce sewer surcharge payments, industries may be required to implement wastewater pretreatment measures. Because of the wide variety of industries and the range of processes and pollutants within a given industry, pretreatment requirements are site specific and can encompass the complete range of environmental engineering technology. The significant "traditional" pollutant parameters in major industrial categories are summarized in Table 7-1. A summary of "priority pollutants" and possible industrial sources has recently been compiled in a five document publication by EPA (1980).

An overview of available treatment technology is presented in Figure 7-1. In general, industrial wastes can be categorized as those amenable to treatment at municipal sewage treatment plants (STP's) and those that are less amenable to treatment in municipal STP's. Typically the wastes treatable at STP's are organic in nature with relatively high BOD, SS, grease and oil concentrations (i.e. from meat packers, fish plants, fruit and vegetable canners, breweries, distilleries, dairies, cheese plants, etc.), whereas less treatable wastes generally contain inorganic contaminants such as metals and dissolved salts (i.e. from metal finishing plants, textile plants, tanneries, chemical plants, steel mills, etc.).

Most pretreatment systems generally include some form of coarse solids separation, grit removal, equalization and often neutralization. The most common pretreatment processes for organic type wastes are: dissolved air flotation; sedimentation, with or without chemical addition; biological treatment (including activated sludge systems and aerated or anaerobic lagoons); and filtration. For inorganic wastes the most common unit processes employed are chemical precipitation, chemical oxidation and activated carbon adsorption. Ion exchange, ultrafiltration, reverse osmosis and other tertiary treatment processes may be employed in specific cases.

A comprehensive compilation of industrial descriptions, pollution abatement technologies, costs, and treatability data has been prepared by EPA (1980). Additional information on treatment of various industrial wastewaters is available from US EPA "development documents" from effluent limitations guidelines (which are referenced by EPA, 1980), and from Environment Canada industrial effluent regulation and guideline reports (Environment

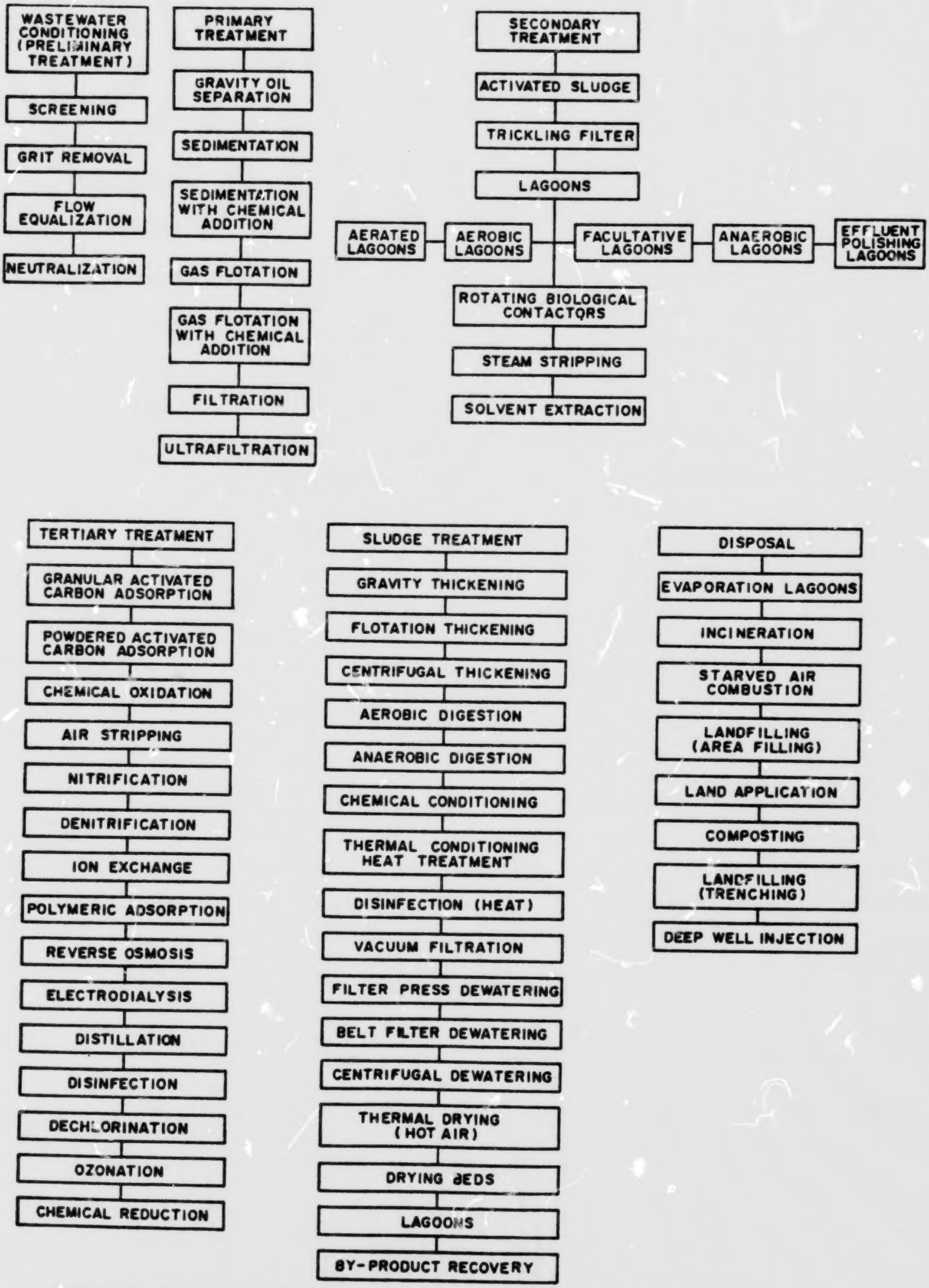

WASTEWATER CONDITIONING (PRELIMINARY TREATMENT)
SCREENING
GRIT REMOVAL
FLOW EQUALIZATION
NEUTRALIZATION
PRIMARY TREATMENT
GRAVITY OIL SEPARATION
SEDIMENTATION
SEDIMENTATION WITH CHEMICAL ADDITION
GAS FLOTATION
GAS FLOTATION WITH CHEMICAL ADDITION
FILTRATION
ULTRAFILTRATION
SECONDARY TREATMENT
ACTIVATED SLUDGE
TRICKLING FILTER
LAGOONS
AERATED LAGOONS
AEROBIC LAGOONS
FACULTATIVE LAGOONS
ANAEROBIC LAGOONS
EFFLUENT POLISHING LAGOONS
ROTATING BIOLOGICAL CONTACTORS
STEAM STRIPPING
SOLVENT EXTRACTION
TERTIARY TREATMENT
GRANULAR ACTIVATED CARBON ADSORPTION
POWDERED ACTIVATED CARBON ADSORPTION
CHEMICAL OXIDATION
AIR STRIPPING
NITRIFICATION
DENITRIFICATION
ION EXCHANGE
POLYMERIC ADSORPTION
REVERSE OSMOSIS
ELECTRODIALYSIS
DISTILLATION
DISINFECTION
DECHLORINATION
OZONATION
CHEMICAL REDUCTION
SLUDGE TREATMENT
GRAVITY THICKENING
FLOTATION THICKENING
CENTRIFUGAL THICKENING
AEROBIC DIGESTION
ANAEROBIC DIGESTION
CHEMICAL CONDITIONING
THERMAL CONDITIONING HEAT TREATMENT
DISINFECTION (HEAT)
VACUUM FILTRATION
FILTER PRESS DEWATERING
BELT FILTER DEWATERING
CENTRIFUGAL DEWATERING
THERMAL DRYING (HOT AIR)
DRYING BEDS
LAGOONS
BY-PRODUCT RECOVERY
DISPOSAL
EVAPORATION LAGOONS
INCINERATION
STARVED AIR COMBUSTION
LANDFILLING (AREA FILLING)
LAND APPLICATION
COMPOSTING
LANDFILLING (TRENCHING)
DEEP WELL INJECTION

FIGURE 7-1 — POINT SOURCE TREATMENT TECHNOLOGY

TABLE 7-1. SUMMARY OF SIGNIFICANT POLLUTANT PARAMETERS FOR MAJOR INDUSTRIES

Industry	BOD	TSS	TDS	COD	pH	Cyanide	Color	Oil and Grease	Phosphorus	Ammonia	Fluoride	Chrome	Copper	Lead	Zinc	Cadmium	Iron	Nickel	Arsenic	Sulfide	Manganese	Mercury	Nitrate Nitrogen	Phenol	Boron	Selenium
Dairy	X	X	X	X	X		X		X																	
Grain mills	X	X	X	X	X				X																	
Canned and preserved fruits and vegetables	X																									
Canned and preserved seafood	X	X		X				X																		
Sugar	X	X	X	X	X																					
Textile	X	X	X	X	X		X	X				X														
Cement																										
Feedlots	X	X	X	X						X																
Metal finishing & electroplating		X			X	X			X		X	X	X	X	X	X	X	X								
Organic chemicals		X	X	X				X		X														X		
Inorganic chemicals		X	X	X	X							X										X				
Plastics and synthetics	X	X	X	X	X			X		X	X	X												X		
Soap and detergents	X	X	X	X	X			X																		
Fertilizer		X			X				X	X	X															
Petroleum	X							X		X		X			X					X				X		
Iron and steel	X					X		X		X				X	X					X	X					
Nonferrous metals		X	X		X			X			X		X	X	X	X			X							X
Phosphates		X	X		X				X		X				X		X		X							
Steam electric power		X			X			X	X			X	X		X		X							X		
Ferroalloys		X			X	X				X		X					X				X			X		
Leather tanning & finishing	X	X		X	X			X				X								X						
Glass	X	X	X	X	X		X	X	X															X		
Asbestos	X		X	X	X																					
Rubber	X	X	X	X				X						X	X											
Timber	X	X		X	X		X	X																X		
Pulp and paper	X	X			X		X																			
Builders paper	X	X			X																					
Meat	X		X	X			X	X																		
Paint and ink	X	X	X	X	X		X	X				X	X	X	X	X	X					X				
Auto and other laundries	X	X	X	X	X			X				X	X	X	X	X	X	X								
Water supply		X	X	X			X				X															
Steam supply		X			X			X	X			X	X		X		X							X		
Misc. foods and beverages	X	X		X	X			X																		
Misc. chemicals	X	X	X	X	X	X		X				X			X		X						X	X	X	

Canada, 1974, 1975, 1977a, 1977b, 1977c, 1977d, 1978). Other good reference material on industrial waste treatment includes the proceedings of annual industrial waste conferences such as the Purdue Industrial Waste Conference and the Ontario Industrial Waste Conference. Recently published handbooks include: Lund, (1981), Cavaseno (1981), Besselievre and Schwartz (1981) and Azad (1981).

7.2.1.3 Alternative Disposal Methods

Industries presently discharging highly contaminated wastewater to municipal or storm sewers may be required to implement alternative disposal methods such as: incineration or hauling wastes to either centralized liquid and special waste treatment facilities (the only site in Ontario is at Sarnia) or a secure landfill, a secure storage site (e.g. PCBs) or a deep well disposal site.

7.2.1.4 Recovery/Reuse

Many industrial wastewaters are, or can become, valuable resources to other users. Some potential applications for relatively uncontaminated wastewaters are listed in Table 7-2 (EPA, 1976). This list is not all inclusive and the PCP planner should compile a similar list for each planning area, taking into account water quality requirements for various beneficial uses (MOE, 1978).

In Canada, the opportunity exists for contaminated industrial wastewaters and by-products to be recycled through the Canadian Waste Materials Exhange, managed by the Ontario Research Foundation. Available waste materials are listed in bi-monthly bulletins. Additional information on recycling through a waste exchange is provided by Vitberg et al (1976).

Specific examples of industrial waste recycling and reuse in Ontario include:

Contaminated Waste

- Waste pickle liquor and other iron wastes are collected, processed and resold for use as phosphorus removal chemicals or iron feed supplements by at least two companies (e.g. Diversey, Mississauga and Rothsay Concentrates, Moorefield).

TABLE 7-2. POTENTIAL CUSTOMERS AND APPLICATIONS FOR WASTEWATER REUSE

CUSTOMER	APPLICATION
Municipal	Irrigation - Public parks, zoo grounds, government centers, etc. - Public golf courses - School grounds - Publicly-owned farm lands - Right-of-way landscaping - Other
	Groundwater Recharge
	Recreational lakes (e.g. stormwater)
	Public utilities - cooling water for power plants
Industry	Cooling water
	Irrigation of grounds
Private or Agricultural	Crop irrigation
	Salt leaching
	Irrigation of - Golf courses - Duck clubs - Recreational areas, including artificial lakes (e.g. stormwater)

- oily industrial wastes, coolants and cutting fluids are collected and processed for reuse by several companies (e.g. Scandex, Kitchener).
- many food processing wastes and sludges are utilized as swine and cattle feed (e.g. Roslyn Park Farm, Petersburg, Ontario; Kaster Farms Ltd., New Dundee).

Relatively Uncontaminated Wastewaters

- irrigation on farmland - St. Jacobs Cannery, St. Jacobs, Ontario.
- reuse as cooling water.

7.2.2 Municipal Treatment Improvements

7.2.2.1 Treatment Plant Upgrading

Many advanced (tertiary) treatment methods are available for the removal of specific pollutants such as phosphorus, nitrogen and organic substances as well as for a general improvement in the treatment plant effluent. Figure 7-1 in the previous section on industrial controls listed the available advanced treatment methods. These can also be applied to upgrading of municipal STP's. In Ontario, emphasis has been placed on reducing phosphorus concentrations generally to 1 mg/L or less by chemical addition and in many specific cases to less than 0.5 mg/L by effluent filtration (i.e. Stratford, Guelph, Orangeville, Milton and Georgetown, etc.). Effluent filtration also reduces the suspended solids and BOD loading to the receiving stream.

In Ontario there is an increasing trend toward requirements for nitrification (by biological oxidation of organic nitrogen and ammonia to nitrate). This is accomplished by providing longer hydraulic retention and solids retention times in biological treatment processes. Design and operational guidelines for nitrification have been outlined by Smith (1977). Ontario plants recently designed for nitrification include, Milton, Elmira and Guelph. No Ontario municipal STP's utilize reverse osmosis, ozonation, ultrafiltration or ion exhange technologies and only one plant (Orangeville) has been required to provide nitrate removal (i.e. denitrification). Operating summaries (including plant descriptions) for all ministry operated STP's are published annually by the MOE (MOE 1969-1980).

The MOE has also recently published "Guidelines for the Design of Sewage Treatment Works" (MOE 1980b).

7.2.2.2 Treatment Plant Operations Improvement

Recent surveys in the United States have shown that approximately 60% of the 3,000 publicly owned treatment plants over 1 mgd are violating their discharge permits. Of the non-complying plants, over 80% have operation and maintenance problems (other causes were inadequate design, hydraulic and organic overloading and failure to account for industrial wastes). While a 1979 survey found similar problems in Ontario STP's, the incidence of O & M problems was not as high (Archer, 1981). This has been attributed to the excellent operator training program provided in Ontario by the MOE, Training and Certification Section (Black, 1981).

Aside from providing on-going staff training programs the other main approach to reducing O & M problems at STP's is private sector provision of O & M services. These can range from design related O & M services to comprehensive contract operations. Presently in Ontario there is only a limited amount of private sector involvement in treatment plant operations because a large number of plants are operated by the MOE. However, there is a trend toward more plants being owned by municipalities which could lead to more opportunities for private sector involvement.

7.2.2.3 Treatment Plant Effluent Discharge Control

In Ontario this usually consists of storing plant effluent in "seasonal retention" lagoons for discharge into the receiving stream at a controlled rate when adequate dilution flow and assimilation capacity is available in the stream (i.e. during spring and fall high flow periods). This alternative is implemented at many small Ontario municipalities.

7.2.2.4 Receiving Stream Modification

Alteration of the natural characteristics of the receiving water body can sometimes provide a cost effective alternative to plant expansion or upgrading. Methods include: instream reaeration; low flow augmentation, or physical relocation of the discharge point. Instream reaeration technologies were recently tested by the MOE during a fish kill on the Nith River resulting from a manure tank dump. Low flow augmentation by the use of dam and reservoir construction is common practice. Direct injection of pure oxygen has been tested on a pilot scale in the Avon River (Heathcote, 1981b). Relocation of municipal effluent discharge has been considered by the City of London (outfall to Lake Erie) and the Town of Elmira (outfall to Grand River).

7.3 Stormwater Runoff Quality (Pollution) Controls

The alternatives available to reduce the impact of stormwater runoff on receiving water quality can be categorized as: source controls; collection system controls and storage/treatment controls. These may be subdivided further into various other categories such as structural/non-structural (Best Management Practices - BMP's); on-site/off-site; upstream/downstream, etc. A detailed discussion of stormwater runoff pollution controls can be found in the "Manual of Practice for Urban Drainage" (COA 1980); the EPA "Areawide Assessment Procedures Manual" (EPA, 1976); and Waller (1976). In addition to these general references, a comprehensive evaluation of a large number of remedial measures to control non-point sources of water pollution in the Great Lakes Basin was conducted by Marshall, Macklin, Monaghan Limited, (1977). A matrix, showing the relative effectiveness of some 109 remedial measures in controlling pollutants from various land use categories was compiled. A brief summary of the most common runoff quality control alternatives is presented in Table 7-3. More recently, the U.S. National Urban Runoff Program (NURP) (EPA, 1982; Driscoll, 1983) has provided detailed data regarding the effectiveness of street sweeping and detention storage for control of pollutants in storm runoff. As well, the IJC's post-PLUARG report (IJC, 1983) evaluated non-point remedial practices (urban and rural) in the Great Lakes basin.

Control of sediment from developing areas also provides pollution control benefits. Reference should be made to Guidelines on Erosion and sediment Control for Urban Construction Sites (MOE, 1983) for details on criteria and techniques.

7.4 Stormwater Runoff Quantity (Flooding) Controls

Whereas stormwater quality refers to the concentration and mass of pollutants in runoff, stormwater quantity refers to the total volume, peak

TABLE 7-3. SUMMARY OF STORMWATER RUNOFF QUALITY (POLLUTION) CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS OR REFERENCES
SOURCE CONTROLS		
1. Street Sweeping	The four most common methods of street sweeping are: mechanical (broom) sweeper; manual; vacuum sweepers and combined vacuum/mechanical sweepers. The mechanical broom sweeper is the most commonly used; however, it is not effective in removing fine (400 micron) particles which contain most of the pollutant load. Frequent mechanical sweeping followed by vacuum.	Technical and cost assessments (APWA, 1969, Morris et al, 1975; Sartor and Boyd, 1972). Applications: Marrivale Industrial Colony, City of Nepean, Ontario - See (COA, 1980a).
2. Control of De-icers and Other Chemicals	The four major categories of chemicals that contribute to storm runoff pollution are: de-icing melts, pesticides; fertilizer nutrients, and heavy metals (mainly from vehicles and rainfall). The use of street de-icing melts such as sodium and calcium chloride can be reduced by such methods as more frequent snow plowing; equipment operator training and using abrasives (i.e. pesticides and herbicides or other chemicals applied to land should be restricted whenever they are found to be causing serious pollution problems.	Sartor and Boyd, 1972, discuss the loadings from various sources. De-icing salt problems and solutions are summarized in MOE, 1975. Pesticide and herbicide use and control; Bovey et al, 1976; EPA, 1975; Marshall, Macklin, Monaghan, 1977. Monaghan, 1977.
3. Erosion/ Sediment Controls	Erosion and sediment control should be considered during the planning stages of development. Control measures include; proper site selection; use of vegetation; use of mulches; drainage channel protection and modification, careful backfilling of sewers, protection of materials stockpiles; sediment retention basins; timing of construction in low erosion season, traffic control, etc.	All control measures summarized by EPA, 1976; Marshall, Macklin, Monaghan, 1977; USDA, 1972. Examples are given by State of Maryland et al, 1972; Schadel et al, 1974; and Wolman, 1975; MOE, 1983.
4. Natural Engineering Control	"Natural engineering" techniques which take advantage of the environment and the original drainage pattern in newly developing areas should be an intergral part of the planning process. The basic principle is to minimize the impact of development on water resources (i.e. maintain groundwater levels and/or base line flows in streams, reduce storm runoff flows and pollution by using a variety of on-site and off-site measures including; use of existing storage (lakes, ponds, quarries, etc.); grass channels or waterways; use of extended overland flow paths in permeable areas.	Principles and Practices summarized in a handbook by Tourbier and Westmacott, 1974. Examples - Woodlands development near Houston, Texas (Evarhart, 1973). Use of interconnected lakelets in Winnipeg to control peak flows (City of Winnipeg, 1975).

TABLE 7-3 (CONT'D). SUMMARY OF STORMWATER RUNOFF QUALITY (POLLUTION) CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS AND REFERENCES
SOURCE CONTROLS (CONT'D)		
5. Porous Pavements	The use of porous pavements in new roads and paved area construction can reduce runoff by decreasing the impervious area. Storm flows and associated pollution loads will be reduced if the underlying soils are sufficiently permeable. Maintenance must be provided to minimize surface clogging. Frost heave problems must be considered in design in Ontario climate.	Field expereince has been limited to research facilities and southern U.S. References: EPA, 1973b; Tourbier and Westmacott, 1974.
6. Air Pollution Control	Particulate materials and chemicals are released to the atmosphere, mainly by: industrial consturction and agricultural activities and automobile and air traffic. When these materials "fallout" on land they add to the pollution load of stormwater runoff. Therefore, control of air pollution at their source will reduce stormwater runoff pollution. Technology for particle removal from stacks includes electrostatic precipitators and scrubbers. Erosion controls also reduce the amount of dust generated from construction and agricultural areas.	Air pollution control. References inlcude: Parker, 1981; and Sainfeld, 1981.
7. Other BMP's	Pollution from urban runoff can be reduced by improving solid waste practices by: enforcing anit-litter laws; providing adequate litter containers; preventing disposal of leaves, used motor oil, etc. in catch basins and by public education programs. Physical enclosure of pollutants such as at bulk fertilizer and road salt/sand storage locations.	Implementation of "used oil well" collection program in Ontario is an example. Use of storage domes to contain road salt at Ontario MTC yards is another example of a BMP.

TABLE 7-3 (CONT'D). SUMMARY OF STORMWATER RUNOFF QUALITY (POLLUTION) CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS AND REFERENCES
COLLECTION SYSTEM CONTROLS		
1. Catch Basin Cleaning or Elimination	Catch basins are intended to prevent sewer clogging by debris during storms. Pollution loadings associated with "first flush" at the beginning of storms are well documented. Reduction of first flush pollution from existing catch basins can be reduced by: more frequent sump cleaning; sump elimination, installation of filter bogs or other sediment-retaining devices. Catch basin elimination (with provision of sediment removal points) should be considered.	Proper catch basin design is discussed by Lager et al, 1972. Bag filter information is available from Hydro Storm Sewage Corporation, 919 3rd Ave., 43rd floor, N.Y., N.Y., 10022.
2. Sewer Flushing	The purpose of sewer flushing is to remove sediment accumulated during dry weather low velocity flow conditions, thus, reducing first flush pollution during storms. Stormwater or combined sewer overflow pollution can be reduced by periodic dry weather flushing to proper treatment facilities.	Costs and efficiency of a sewer cleaning program in Boston: Pisano, 1975. FMC Corporation (1976) provides details on a portable flushing system for combined sewers.
3. Improved Regulators	Quantity control regulators are discussed in Table 7-4. New quantity and quality control regulators are being developed. These include: fluidic devices, swirl concentrators; vortex regulators; high side spill weirs; stilling pond regulators and spiral flow (Helical Band) regulators. These devices concentrate and separate sediment from combined sewage with contaminants discharged to the interceptor sewer for treatment.	References: General APWA, 1975a and 1975b. Swirl concentrator - APWA, 1972. Helical band regulator - Sallwan et al, 1975.
4. Sewer Separation	Separation of sanitary sewage from stormwater can be achieved in three ways; by adding a new sanitary sewer and using the combined sewer as a storm sewer; by adding a new storm sewer and using the combined sewer as a sanitary sewer; or by adding a "sewer within a sewer" pressure system. Partial or complete separation can be achieved depending on whether all foundation and yard drains are connected to the storm sewer.	Canadian references are Marsalek, 1972 and COA, (1980a).
5. Remote Monitoring and Control	Combined sewer systems can be upgraded by installing automatic regulators, rain gauge networks, sewage and receiving stream quality and flow measurement devices, and then applying computerized collection system controls to assist in storage and treatment optimization.	References: Minneapolis-St. Paul, Metropolitan Sewer Board, 1971. Detroit Metro Water Department, 1975.

TABLE 7-3 (CONT'D). SUMMARY OF STORMWATER RUNOFF QUALITY (POLLUTION) CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS AND REFERENCES
STORAGE & TREATMENT	Storage and resulting sedimentation can be regarded as a treatment process.	
1. In-Line Storage	In-line storage utilizes the unused volume within major collectors and interceptors during most storms. In-line storage is created by: forcing water to backup in major conduits by a dam, gate, other regulator, or by using inlet controls to create on-site storage (i.e. in streets, parking lots, roofs, etc.).	Effects of various storage alternatives have been evaluated by Henry and Ahern, 1976.
2. Off-Line Storage	Methods of off-line storage structures include: ponds, lagoons, underground silos, deep tunnels, primary settling tanks, underwater bags and void spaces. Flows can either be diverted for further treatment or released to the receiving water after sedimentation in the holding structure has reduced the pollutant load. Retention/detention concepts are discussed in Table 7-4.	
3. Treatment Facilities	The treatment processes currently considered for reduction of pollution from storm sewer discharges and combined sewer overflows are: barracks, swirl concentrator/regulators; fine screens; sedimentation; dissolved air flotation; microstrainers; high rate filters; biological treatment; effluent screens; high rate disinfection. A brief description of these options which are incorporated into the stormwter management model SWMM is presented in Appendix B.	Selecting and sizing treatment facilities for stormwater or CSO treatment are discussed in the Urban Drainage Manual, COA (1980a). Treatment texts and manuals available are: Lager and Smith, 1974.

flow and rate of runoff. While flood control in flood-plain near water courses is well understood (Ontario Flood Plain Steering Committee, 1977), flood prevention technology in urban areas away from natural water courses is not as well advanced. Only recently did the principle of major and minor storm drainage systems become recognized as an essential consideration in the design of stormwater drainage systems. The minor (piped) system is designed to minimize inconvenience or disruption of activity from less intense storms. The major system is the route followed by runoff flows when the sewer system is overloaded. It is very important that both the minor and major systems be properly designed to handle the flows for which each is best suited. Design criteria for each are discussed in the Urban Drainage Design Guidelines (MOE, 1984).

The references cited in the previous section on runoff quality controls also contain information on quantity controls. Methods to control the quantity of stormwater runoff can be categorized as: runoff reduction or control; and collection systems controls. A brief summary of the most common stormwater runoff quantity control alternatives is presented in Table 7-4. Specific information is available from several COA research reports and PLUARG reports.

7.5 Infiltration and Inflow Controls

A summary of inflow sources and corresponding corrective measures is presented in Table 7-5. Infiltration sources and corrective measures are summarized in Table 7-6. For further detail on I/I remedial alternatives, refer to COA (1980a) and EPA (1975).

TABLE 7-4. SUMMARY OF STORMWATER RUNOFF RATE AND VOLUME CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS OR REFERENCES
RUNOFF REDUCTION OR CONTROL		
1. Roof Leader and Foundation Drain Disconnection	In many older developments in Ontario, roof and foundation drains are connected to the sanitary sewer. This is undesirable because flooding (hydraulic overloading) of sewage treatment facilities results during storms. When connected to storm sewers improperly, basement flooding can occur. Roof leaders may be disconnected from sewers and may discharge directly into a graded ground surface sloping away from the structure, by percolation and surface storage. A separate foundation drain collector (FDC) system (i.e. small third sewer system is one method of separating foundation drainage.	FDC systems have been installed in several Ontario subdivisions.
2. Natural Runoff	Proper site and lot grading can reduce stormwater runoff flows by maximizing percolation and surface storage. The use of shallow, open grassed ditches and swales in place of curb, gutter and storm sewers can reduce runoff rate and volume. The change in friction factor in natural channels increases the depth of flow and increases storage.	Grassed ditches and swales are in common usage in Ontario, Urban Drainage Design Guidelines (MOE, 1984).
3. On-Site Detention	Temporary detention for delaying or slowing the rate of stormwater runoff to the sewer system can be provided by: street swales, roof storage; parking lot storage or on-site surface detention basins and ponds. Storage is created and rate of discharge is controlled by a flow regulator at the inlet to the storm or combined sewer.	Reviewed by Poertner, 1974 and Ontario study by Ahern and Henry, 1975; see also MOE, 1984. Examples are: Merivale Industrial Colony, City of Nepean (roof ponds); Upper Canada Mall Newmarket, Ontario (stormwater detention pond).
4. On-Site Retention	On-site retention generally denotes total containment of stormwater runoff with no overflow from the storage basin (i.e. retained water either recharges the groundwater or evaporates). However, temporary retention of combined sewage with subsequent release after the storm, to treatment facilities is also practiced. In the literature the terms detention/retention are often used interchangeably.	Retention basin for Combined Sewer Overflow, Welland, Ontario; Tonelli, 1977; Retention/recharge of storm drainage, Town of Paris, Ontario (see COA 1980a). Others: City of Halifax, Nova Scotia; Borough of York (Toronto), Ontario.

TABLE 7-4 (CONT'D). SUMMARY OF STORMWATER RUNOFF RATE AND VOLUME CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS AND REFERENCES
RUNOFF REDUCTION OR CONTROL (CONT'D)		
5. Erosion Control	Control of the amount of sediment discharged into the sewer system reduces the build-up of deposits which affect the capacity of the sewer system. Surcharging and flooding will be reduced if the full sewer capacity can be maintained. Erosion/sediment controls are summarized in Table 7-3.	
6. Porous Surfaces	The imperviousness of driveways and parking areas can be reduced by: porous asphalt pavement; precast interlocking blocks; rolled brick and cinder chips. French drains (gravel ditches), may be used in impervious ground surface areas to intercept street runoff, allowing it to percolate into the ground.	References: Thelen et al, 1972 (porous pavement).
COLLECTION SYSTEM CONTROLS		
1. Sewer Cleaning, Maintenance, Repair and Replacement	The most commonly used types of equipment for sewer cleaning are: rodding machines, bucket machines, high velocity water machines; hydraulically propelled devices, trash pumps and vacuum machines. Regular inspection and maintenance of sewers, catch basins, inlets/outlets and regulators is beneficial. The three basic rehabilitation methods are: chemical granting; pipe lining and excavation/replacement. Detailed studies should be conducted before replacing undersized sewers with larger ones.	EPA, 1975, provides detailed descriptions and costs for sewer rehabilitation.
2. Inflow and Infiltration Reduction	Inflow controls generally have the greatest potential for stormwater quantity reduction. The most common inflow sources and corresponding controls are summarized in Table 7-5. Disconnection of roof leaders, foundation drains and cooling water discharges requires by-law adoption and enforcement. Infiltration sources and corresponding controls are summarized in Table 7-6. Most of these are related to deterioration of the collection system and infilration reduction is usually accomplished in conjunction with major sewer rehabilitation progams.	Procedures for conducting comprehensive inflow/infiltration analyses are outlined in the "Handbook for Sewer Evaluation Rehabilitation", EPA, 1975. Surveys have been conducted in several Ontario municipalities (i.e. Elmira, etc.), but none have been as the highly systemized EPA procedure.

TABLE 7-4 (CONT'D). SUMMARY OF STORMWATER RUNOFF RATE AND VOLUME CONTROL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	APPLICATIONS AND REFERENCES
COLLECTION SYSTEM CONTROLS (CONT'D)		
3. Improved Regulator and Flap Gate Operation	Regulator station design should minimize unnecessary overflow, while not exceeding interceptor sewer or treatment capacity. Quantity control regulators are categorized as: static; semi-automatic dynamic and automatic dynamic. Present practice in Ontario is static regulators so there is room for improvement. Quantity and quality regulators are discussed in Table 7-3.	Regulator and flap gate problems and descriptions are discussed by APWA, 1975a, who also developed a manual of practice for these devices (APWA, 1975b).
4. Polymer Injections	Polymer injections into overloaded sewers during storms results in reduced friction and thus, increased sewer capacity (i.e. up to 144% increase capacity in some tests). This method may provide at least a temporary alternative to enlargement of overloaded sewers.	Examples: in Richardson, Texas and Dallas, Texas; Lager and Smith, 1974. In Bergan Co, New Jersey, Anon, 1978.
5. Flow Rating on Diversion	Flood relief can be achieved by routing flows from overloaded parts of the system to other parts receiving less runoff to optimize in-line storage. Extensive monitoring and control is required for flow routing to be operated effectively. Surface runoff diversion from areas with high erosion potential can be accomplished by: diversion channels; diversion berm, or bench traces.	Lager and Smith, 1974 discuss flow routing in Seattle, Washington. Anderson and Meyer, 1976, discuss computer controlled flow routing. Surface flow diversion is common practice.
6. Sewer Separation	In combined sewer areas, sewer separation can alleviate flooding problems. Sewer separation was discussed in Table 7-3.	
7. Sewer De-separation	In overloaded sanitary systems (with many random sewer cross collections) basement flooding or sanitary overflow can result. In such situations, systematic inter-connection of parallel sanitary and storm sewers (resulting in increased hydraulic capacity during storms) is one method of flood prevention. Off-line storage and routing controls must be used with deseparation to prevent pollution.	This method has limited application, but one example is given by Anderson and Myers, 1976.

TABLE 7-5. INFLOW SOURCES AND CORRECTION MEASURES

TYPE OF INFLOW AND ORIGINATING LOCATION	POSSIBLE CORRECTION METHODS
Usually in the Collection System	
Low-lying manholes	Manhole raising
Perforated manhole covers	Partial plugging or replace with watertight covers
Cross connections (from separated sewers)	Plugging, diversion drainage
Back flow from receiver	Improved flap gate installations, changing overlow locations
Drains from springs and swampy areas	Plugging, diversion drainage
Usually on Private Property	
Roof leader drains	Disconnection
Foundation drains	Disconnection
Yard drains	Plugging
Area drains	Plugging
Cooling water discharges	Disconnection

TABLE 7-6. INFILTRATION SOURCES AND CORRECTION METHODS

SOURCES	POSSIBLE CORRECTION METHODS
Collapsed pipe	Replacement; slip-lining
Broken or crushed pipe	Replacement; slip-lining
Cracked pipe	Slip-lining; lining with cement, mortar or epoxy mortar; replacement
Deteriorated pipe joints	Chemical grouting
Leaking off-set joints	Slip-lining; chemical grouting; replacement
Open joints	Slip-lining; chemical grouting; replacement
Deteriorated mortar joints in brick pipes	Brick mortar replacement
Leaking house service connections	Chemical grouting; slip-lining; replacement
Faulty taps between sewers and manholes	Excavation and repair
Faulty taps between service connections and main sewers	Excavation and repair
Collapsed manhole and wet wells	Replacement
Deteriorated manhole walls, bases and troughs	Lining with cement mortar or epoxy mortar; chemical grouting; cement grouting
Deteriorated mortar joints in brick manholes	Brick mortar replacement
Deteriorated wet wells and pumping station structures	Lining with cement or epoxy mortar
Other sources such as deteriorated regulators, tide gates, etc.	Repair according to situation

CHAPTER 8

POLLUTION CONTROL PLAN SCREENING

8.1 Introduction

Decision makers faced with classical water resources problems have generally applied cost-benefit analysis to identify trade-off opportunities and help structure decision making. Cost-benefit analysis is intended to weigh the value (benefits) of projects or programs against their costs. Projects whose benefits exceed their costs are said to be feasible. In the context of Ontario water quality management, however, ambient water quality criteria have already been set by the regulatory agency (MOE) presumably in recognition of the benefits provided by natural waters of the required quality. Hence, given the Provincial Water Quality Objectives (PWQO) the purpose of PCP decision making is to identify the least-cost solutions meeting PWQO requirements. (Although, some thought should be given to the underlying benefits as discussed later in this section.) Traditionally, one might call this cost-effectiveness analysis and as already noted the objective is to arrive at the best solution to the water quality problem(s) under consideration. The "best" solution may not, however always be the least-cost since other considerations which carry great force in "real" world situations need to be included in crafting a control plan. For example, if a rural and urban area both contribute say phosphorus loadings to a receiving body, quite often the cost-effective approach to meeting phosphorus requirements will be reductions in urban point source effluents with little or no reduction in the far more diffuse rural sources. From the standpoint of the urban dweller this represents an inequitable solution which he or she may oppose since only one of the parties contributing to the problem is contributing to the remedy. Screening procedures therefore must be sufficient in scope and flexibility to allow for such questions as equity.

The following sections present first a discussion of some of the major considerations and problems involved in making pollution control decisions followed by the presentation with examples of the decision analysis methodology.

8.2 Formulation, Evaluation and Screening of Pollution Control Plans

8.2.1 Overview

The objective of developing and screening pollution control plans is of course to identify the alternative with the greatest merit. The process is illustrated in Figure 8-1 and each step is discussed in detail in the following sections. Although the process is shown as linear in nature it is understood that like most other decision processes it is actually iterative with any number of the steps repeated until what is perceived as the "best" plan identified.

8.2.2 Identification of Pollution Control Measures

Based upon the understanding of the behaviour of the pollutant sources and the receiving water gained during the problem definition stage it should be possible to identify suitable potential control measures or abatement actions. At this point, identification of the measures are on a source and pollutant specific basis. For example, if a receiving water is impaired by bacterial and heavy metal inputs from a combined sewer overflow and by bacterial inputs from dry weather intermittent sources (i.e. cross-connections) an initial list of control measures requiring consideration might be as follows:

LIST OF POTENTIAL CONTROL MEASURES

Source	Pollutant Species	Potential Control Measures
C.S.O.	Heavy Metals	1) retention storage 2) sewer separation 3) sewer use controls (reduction industrial inputs)
C.S.O.	Bacteria	1) high rate disinfection 2) retention storage 3) sewer separation
Dry Weather Intermittent	Bacteria	1) interception and central treatement 2) local treatment 3) elimination cross-connections.

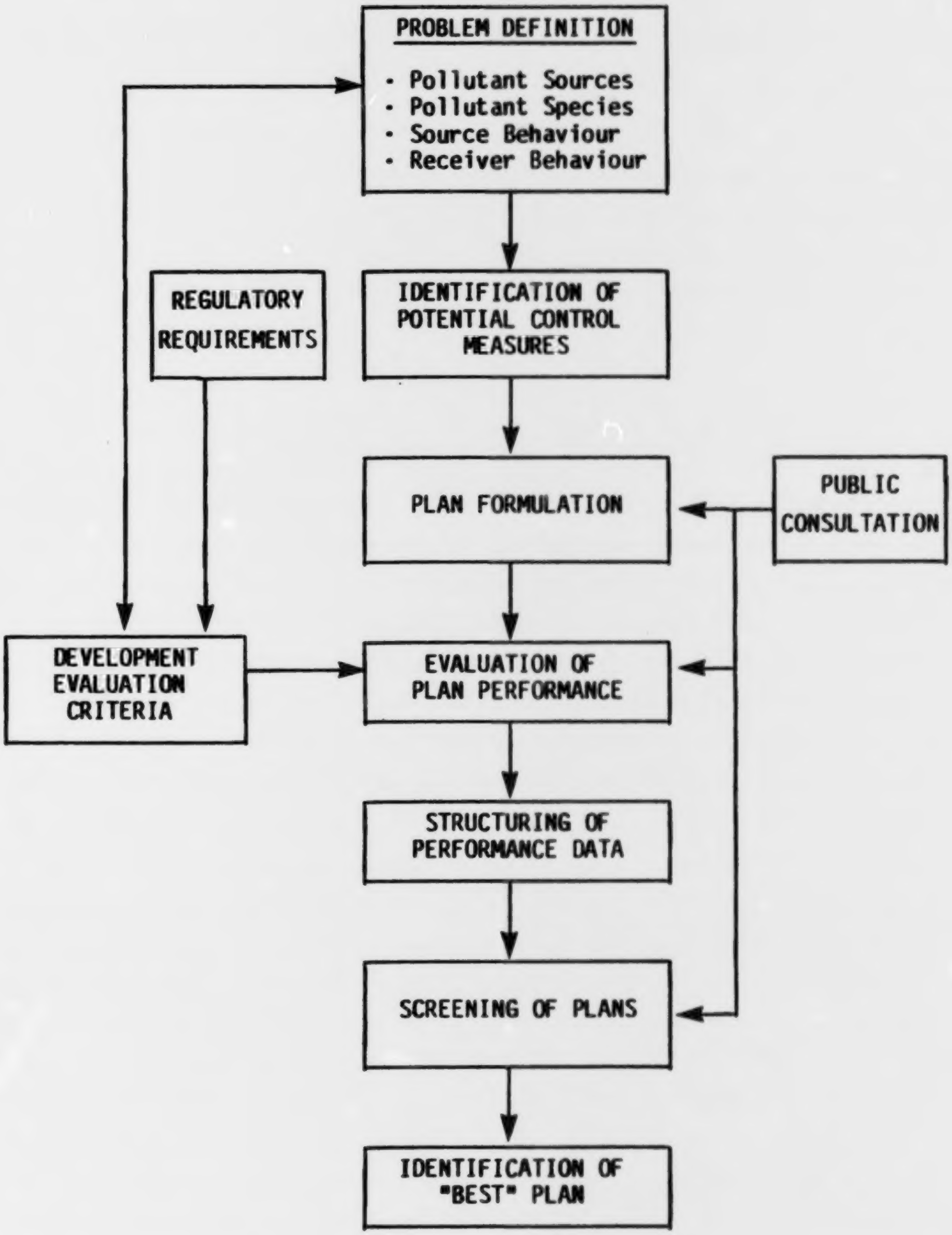

PROBLEM DEFINITION
• Pollutant Sources
• Pollutant Species
• Source Behaviour
• Receiver Behaviour
REGULATORY REQUIREMENTS
IDENTIFICATION OF POTENTIAL CONTROL MEASURES
PLAN FORMULATION
PUBLIC CONSULTATION
DEVELOPMENT EVALUATION CRITERIA
EVALUATION OF PLAN PERFORMANCE
STRUCTURING OF PERFORMANCE DATA
SCREENING OF PLANS
IDENTIFICATION OF "BEST" PLAN

FIGURE 8-1 - FORMULATION, EVALUATION AND SCREENING OF POLLUTION CONTROL PLANS

Note that only two of the four potential C.S.O. control measures are applicable to both pollutant species. Note also that the controls and abatement progam suggested for the dry weather intermittent source are independent from the C.S.O. control measures. If more sources and other pollutants were concerned, a larger list of possible measures could be identified. The point is that no rigorous means of identifying potential measures exists. Rather, reliance is placed upon the expertise and insight of the analyst to identify useful alternatives. The listing(s) may be as extensive as desired given the understanding that subsequent screening effort will be materially increased.

8.2.3 Plan Formulation

The grouping of pollution control measures in alternative plans is the next step in the process. Again, heavy reliance is placed upon the knowledge of the analyst in formulating the alternatives. Taking up the previous example, the following alternative plans might result:

DESCRIPTION OF ALTERNATIVE POLLUTION CONTROL PLANS

Alternative Plan	C.S.O.		Dry Weather Intermittent
A-1	retention storage	+	elimination of cross-connections.
A-2	retention storage	+	local treatment
A-3	retention storage	+	interception and central treatment
B-1	retention storage + sewer separation	+	elimination of cross-connections
C-1	retention storage + high rate disinfection	+	do nothing

In this case a systematic effort is made to examine all feasible permutations and combinations to solve the total problem (bacteria and heavy metals). Although two sources contribute bacteria it may be feasible to resolve the above problem by tackling only one source as is indicated in plan C-1. Furthermore, control measures for a given source may be put together in various combinations to give new plans, such as in B-1 where storage and separation are both considered.

Where a given pollutant source does not interact with other sources and is the sole source of the pollutant, measures for that source need not be considered in connection with plan formulation for multi-source problems. In effect, for single or non-interactive sources, a separate mini-plan is developed and then intergrated at a later stage.

To illustrate, take the previous problem but assume that in addition to the sources of bacteria and heavy metals an industry discharges a hazardous solvent. Since the industry is the only source of the solvent the measures suited to controling its discharge can be evaluated independently and the optimum measure added to the best plan for controlling the bacteria and heavy metals.

8.2.4 Development of Evaluation Criteria

Evaluation criteria serve as measures of the "goodness" of a given alternative. For example, an alternative achieving the desired control over a pollutant source and hence achieving the desired ambient water quality would be considered a "good" alternative. However, if another alternative were able to achieve the same degree of control but at a lesser cost it would be considered a "better" alternative. Other criteria such as the environmental impact of carrying out the alternative or the social implications of implementing it should also be considered. Thus the decision maker is faced with selecting an aternative(s) in light of multiple objectives (e.g. water quality, cost, social impact). The first step in arriving at the decision is to select the appropriate evaluation criteria and by some means give weight to their relative importance. For instance, taking two alternative pollution control plans where the more expensive plan meets water quality criteria and the less expensive does not, the decision would likely be to take the more expensive that meets objectives. In this case, one would say that meeting water quality objectives has a greater weight than cost.

Different decision makers may place different value (i.e. weight) on given criteria. The issue of multiple decision makers and methods of allowing for their preferences is, however, beyond the scope of this report.

The reader is referred to Cohon and Marks (1975) for an overview of mult-objective planning techniques. Henceforth, it will be assumed for sake of simplicity that a single decision maker is involved in developing criteria and screening alternatives.

The following represents some of the more important general categories of evaluation criteria:

1. Water Quality
   Does alternative meet water quality or effluent objectives?
2. Economic
   What is the total cost of the alternative considering the time value of money (i.e. discounting future outlays)?
3. Environmental
   Will implementing the alternative result in significant environmental impacts (e.g. dredge spoil disposal)?
4. Social
   Will implementing the alternative result in social disruption?

Examples of the above, as well as other criteria are presented by Munn (1975) and in the MOE/MEA guidelines for class environmental assessment MEA (1983).

The following sections discuss the water quality and economic criteria in some additional detail. The MEA (1983) guidelines should be reviewed for enviromental and social aspects.

Water Quality

These criteria will be specified as numeric water quality objectives as given in Table 2-3 or as the effluent objectives for given pollutant sources derived from the water quality objectives. For some substances explicit numeric criteria are not as yet available. MOE staff should be consulted to identify concerns relating to such substances and to specify suitable interim criteria.

In general, an attempt should be made to translate water quality criteria into effluent criteria since this enables for easier screening of alternatives. The following example illustrates the relationship of water quality to effluent criteria.

Assume that excessive BOD inputs result in an average stream dissolved oxygen concentration below water quality objective requirements. It is possible then to calculate (although not in all circumstances) the effluent BOD loadings that would not meet objectives. (In practice, some allowance for reserve capacity might be subtracted from the allowable loadings.)

These allowable effluent loadings could be used as the new evaluation criteria. It must be emphasized, however, that the effluent criteria should relate directly to the water quality criteria. Surrogate effluent criteria with unspecified relationships to water quality should be avoided. Stormwater quality control facilities with effluent objectives specified as containment of a precipitation event of give duration and frequency (e.g. containment of 2 hour, 2 year storm) are classic examples of undesirable surrogate effluent criteria.

The numeric form of the effluent or water quality criteria will vary according to the nature of the pollutant source the pollutant species and the receiving water. Criteria may be stated as loadings or concentrations specified for some time period (e g. average daily load), as maximum loads or concentrations or more generally as the frequency of occurrence of loadings or concentrations of a given magnitude. Continuous point source inputs tend to be specified as average or maximum loadings and concentrations whereas intermittent sources are more likely to have criteria in terms of the frequency of occurence of specified events.

A number of problems typically arise in the process of specifying water quality evaluation criteria. Firstly the water quality objectives themselves are only yardsticks implying the ability to employ a water resource for a beneficial use. If no possibility for that use exists (e.g. bathing in ship docking areas) then some considerations should be given in downgrading the weight given to the criteria (e.g. indicator bacteria) supporting the particular beneficial use.

Sometimes the water quality or effluent criteria do not adequately capture the impact upon beneficial use. Using bathing criteria as an example, the required water quality is stated as a mean bacterial density. Stated in this manner, however, the criteria does not give an adequate "feel" to the decision maker of the impact of bacteria upon bathing availability (i.e. number of available bather days when beaches are not closed). The better measure of water quality would be available bather days. Accordingly, when specifying water quality criteria consideration should be given to identifying the criteria which best represents any beneficial use(s).

Some care should also be exercised to avoid double-counting when specifying criteria. Take for example the following problem. "Excessive phosphorus inputs result in luxuriant aquatic plant growth which in turn dominates the dissolved oxygen regime causing large diurual swings which stress fish life". Possible evaluation criteria for the above include phosphorus, plant biomass, dissolved oxygen and fish population. They all describe basically the same problem. The best criteria may be any of the above and in general will be determined by the specific circumstances of the individual case.

It may not always be feasible no matter what controls are brought to bear to achieve the desired water quality criteria. In such cases alternative plans should be judged in terms of how much water quality improvement (i.e. movement towards achieving the criteria) they provide. Otherwise, it is suggested that meeting Provincial Water Quality objectives should be given the highest weighting. Depending upon the nature of the problem it may be desirable to use the water quality criteria as a first screening measure and consider subsequently only those plans meeting or exceeding the desired criteria. Some care should however be exercised when using "must meet" screening for water quality problems described in multiple pollutant species. All of the pollutant criteria may not carry the same priority. Consideration should therefore be to give to relative weighting amongst the criteria and limiting the number of "must meet" criteria.

Economic

Each pollution control plan will result in both capital and operating costs needed to implement the measures making up the plan (direct costs). The following items should be considered in calculating direct costs:

1. construction and equipment
2. engineering and contingencies
3. land, right-of-way, easements
4. administration
5. operating and maintenance
6. capital replacement where the planning period exceeds the life of the structure(s) and/or equipment.

Reference should be made to James and Lee (1971) for considerations in evaluating each of the cost components.

Expenditures associated with each of the pollution control plans may not occur with the same timing (e.g. some alternatives may be staged). In order to obtain a common evaluative base, the present value of the costs for comparable planning periods should be calculated and used for comparison. Some conflict of opinion exists in identifying an appropriate discount rate for the present value calculations. The Treasury Board of Canada [Benefit-Cost Analysis Guide (1976)] suggests 10% whereas the Ministry of Natural Resources [MNR (1983)] requires a 7% rate be used for flood and erosion control projects. A range of rates should be used for pollution control plan screening

8.2.5 Evaluation of Plan Performance

Once evaluation criteria have been identified and alternative pollution control plans developed, plan performance with respect to each of the criteria is assessed. A "do-nothing plan" is usually included in the performance assessment to define the present state of water quality or effluent loading and to act as a benchmark against which the performance of other plans are assessed. Evaluation of the "do-nothing" option should also be carried out for conditions at the end of the planning period to identify any changes in the nature of existing impacts with time.

The assessment of performance with respect to evaluation criteria in the water quality group will usually require some form of modelling (at whatever level of sophistication necessary). Where pollutant-source receiving water interactions are complex such as in the Grand River example of Chapter 6, modelling requirements will be sophisticated and often expensive. Nevertheless, each proposed plan with its set of different control alternatives, different sized alternatives or alternatives with different implementation timing will require evaluation. Judgement should therefore be excercised when formulating plans to include only those with some potential for meeting criteria.

The economic, social and environmental groups will also require an assessment of the evaluation criteria for each of the plans. For example, the present value of costs for each of the plans should be developed. As well, it may be necessary to identify the environmental and social impacts (by whatever criteria are appropriate) resulting from the implementation of a particular plan. Again, as for the the water quality group the "do-nothing" option, present and future, should be evaluated. In economic terms "do-nothing" should have no costs associated with any of the control measures although other costs (e.g. needed repair) may still result. These should be identified and included under the "do-nothing" option. The evaluation of environmental and social impacts of plan implementation also require a "do-nothing" option to serve as a basis for identifying changes in the environment or social structure of a community or area. In both cases "do-nothing" amounts to describing the existing environment or social structure.

The following simplified example illustrates the evaluation process and suggests a means for structuring performance data.

Problem:

Statement: Excessive phosphorus inputs to a small lake result in luxuriant algal growth which adversly affects the lake DO regime, and hence, aquatic organisms. Two major sources of phosphorus input have been identified as WPCP effluent and urban runoff. Analysis has indicated that the lake could sustain loadings of 500 kg per year of total P without excessive algal production. The WPCP is estimated to presently contribute 1,750 kg per year while the runoff contributes 250 kg per year (exclusive of snow melt). The community is not expected to grow over the planning period.

Potential Control Measures:

Runoff

- enhanced street sweeping
- runoff interception and treatment
- runoff diversion to nearby water body

WPCP

- advanced P removal
- effluent diversion to nearby water body

Alternative Pollution Control Plans:

Plan Number	Plan Description: WPCP		Plan Description: Runoff
A-1	advanced P removal	+	enhanced street sweeping
A-2	advanced P removal	+	do nothing
A-3	advanced P removal	+	runoff diversion
A-4	advanced P removal	+	runoff treatment
B-1	effluent diversion	+	runoff diversion
B-2	effluent diversion	+	runoff treatment

B-3	effluent diversion	+	do nothing
B-4	effluent diversion	+	enhanced street sweeping
C-1	do nothing	+	enhanced street sweeping
C-2	do nothing	+	runoff treatment
C-3	do nothing	+	do nothing
C-4	do nothing	+	runoff diversion

The set of C alternatives with a WPCP do-nothing component are clearly not feasible since they would not approach the desired effluent loading.

Evaluation Criteria:

Group	Criteria	Target Value
Water Quality	total phosphorus loading	500 kg/year
Economic	present value of project cost	minimum

Plan Evaluation:

Runoff: Modelling of street sweeping in consideration of local land-use, street surface conditions, climatology and other factors indicate that a maximum of 15% reduction in P loading can be achieved by this means. Runoff diversion and runoff treatment could be implemented in a number of different sizes. For purposes of the present example, it is assumed that only a runoff diversion capacity giving an average annual 90% reduction of total P loads is considered and that only a runoff treatment capacity giving an average annual 60% reducting of total P loads is considered. Modelling would be required to assess the average annual reductions in both cases.

WPCP: Based upon previous experience and some bench-scale testing, advanced P removal is found to provide a maximum of 67% removal of the phosphorus presently in the WPCP effluent (the plant currently practices conventional P removal). It is assumed that 100% of the effluent is diverted if diversion is to be used. Partial effluent diversion is possible but not considered in this case.

The aspect of present and future conditions does not enter into this example, since no community growth is expected.

PLAN PERFORMANCE EVALUATION MATRIX

PLAN NUMBER	CRITERIA	
	WATER QUALITY	ECONOMIC
	ANNUAL TOTAL P LOADING (kg)	P.V. COST ($ K)
A-1	615	200
A-2	828	50
A-3	603	4,050
A-4	678	2,550
B-1	25	6,000
B-2	100	4,500
B-3	250	2,000
B-4	213	2,150
Do-Nothing	2,000	0

A screening of these plans would suggest that plan B-3 is superior since it achieves target requirments at the least cost. Most often, the screening process is not this simple. The next section develops and illustrates a screening method for more complex problems.

8.2.6 Details of the Screening Stage

The screening analysis uses a matrix of the type indicated in Table 8.1. The first column represents a listing of permutations and combinations of the viable alternatives. Evaluation criteria are first weighted according to their relative importance and aggregated into groups of equal importance designated high, medium and low.

TABLE 8-1. PRELIMINARY SCREENING MATRIX

	HIGH IMPORTANCE CRITERIA	MEDIUM IMPORTANCE CRITERIA	LOW IMPORTANCE CRITERIA
LIST OF ALTERNATIVES (including permutations and combinations)			
1.	....	....	....
2.	....	....	....
3.	....	....	....
4.	....	....	....
.			
.			
.			
N	....	....	....

Note: Entries in the matrix may be qualitative descriptions (e.g. very large, large, medium, small, very small).

The decision of what criteria to include in each of these categories is probably best made at a working level with the selected list being circulated for review by other interested parties. (Again, there may well be a refinement of these criteria as the study proceeds.) The sets of detailed criteria (high, medium and low) are then placed along the top row of the matrix.

The next stage in the analysis consists of an appropriately detailed analyses to determine the individual elements of the matrix (for each alternative, to estimate the value of or impact upon each of the criteria).

The next step in the analysis is to identify the dominant alternative(s). Specifics of dominance testing are as follows:

(1) Each of the alternatives is marked in numerical order (e.g. 1, 2, 3....) with respect to each of the individual evaluation criteria. Where two alternatives are equal, they are assigned identical ranks. A new matrix consisting of just the rankings of the alternatives is then prepared.

(2) Pairs of alternatives are then compared to select the preferred alternative from each pair. By examining successive pairs, a rank ordering of the total array of alternatives is thus established. Emphasis in the pairwise comparison is focused on the "high" importance criteria but in the event of an apparent tie (or close to a tie), attention is then focussed on "medium" importance criteria, and so on.

Other key considerations regarding the screening methodology include:

(1) The ranking of importance for decision factors into three levels (or, if desired, more than three) is intended to categorize the factors into those of equivalent concern.

(2) The matrix approach can be employed to identify impacts for various temporal phases of an initiative and to describe impacts associated with various spatial boundaries (e.g. at a site and in a region). Therefore, in an individual application of the methodology more than a single matrix may be employed, one being for immediate considerations and another being for future considerations where, for example, an upgrading of environmental quality levels is envisaged.

The following example is used to illustrate matrix technique and to explain the approach to dominance testing.

8.2.7 Example of the Use of the Screening Matrix Method

A hypothetical example is presented below to demonstrate the screening procedure.

Problem Statement:

Two communities (A and B) are tributary to a river, as is illustrated in Figure 8-2. Downstream of the communities is a beach area that is highly prized as a recreational amenity by the citizens of both communities. The river passing through the communities receives in dry weather intermittent inputs of untreated wastewater from storm outfalls due to sanitary-to-storm cross-connections. In wet weather, both communities discharge stormwater to the river, in addition to the occasional wet weather sanitary bypass originating from the WPCP serving community B.

Due to the combined effects of wet and dry weather inputs, fecal coliform densities at the beach are consistently (90% of the time) in excess of bathing criteria and as a result, body contact recreation is not permitted. Figure 8-3 shows the present distribution of fecal coliform densities during bathing periods.

The local Medical Officer of Health (MOH) has stated that in order to achieve beach opening, the following criteria must be met:

1) No discharge of untreated sanitary wastes in dry weather.
2) No discharge of untreated sanitary wastes in wet weather.
3) No greater exceedance of the 100 org/dL fecal coliform criteria than 10% of the time during bathing periods.

Significant population growth is not expected in either community during the planning period.

Evaluation Criteria:

Proposed evaluation criteria including their relative weights are presented in Table 8.2.

Control Alternatives:

Table 8-3 gives the listings of potential control alternatives on a source specific basis.

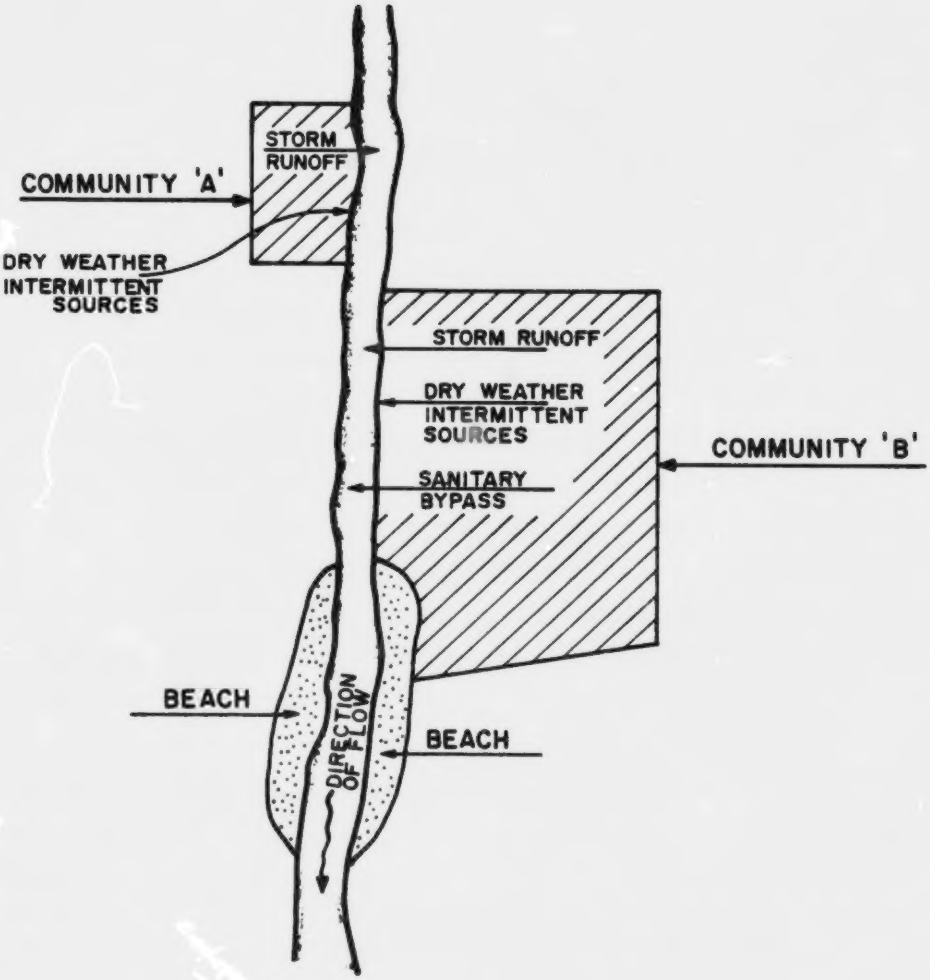

STORM RUNOFF
COMMUNITY 'A'
DRY WEATHER INTERMITTENT SOURCES
STORM RUNOFF
DRY WEATHER INTERMITTENT SOURCES
COMMUNITY 'B'
SANITARY BYPASS
BEACH
DIRECTION OF FLOW
BEACH

FIGURE 8-2 — SCHEMATIC OF HYPOTHETICAL EXAMPLE

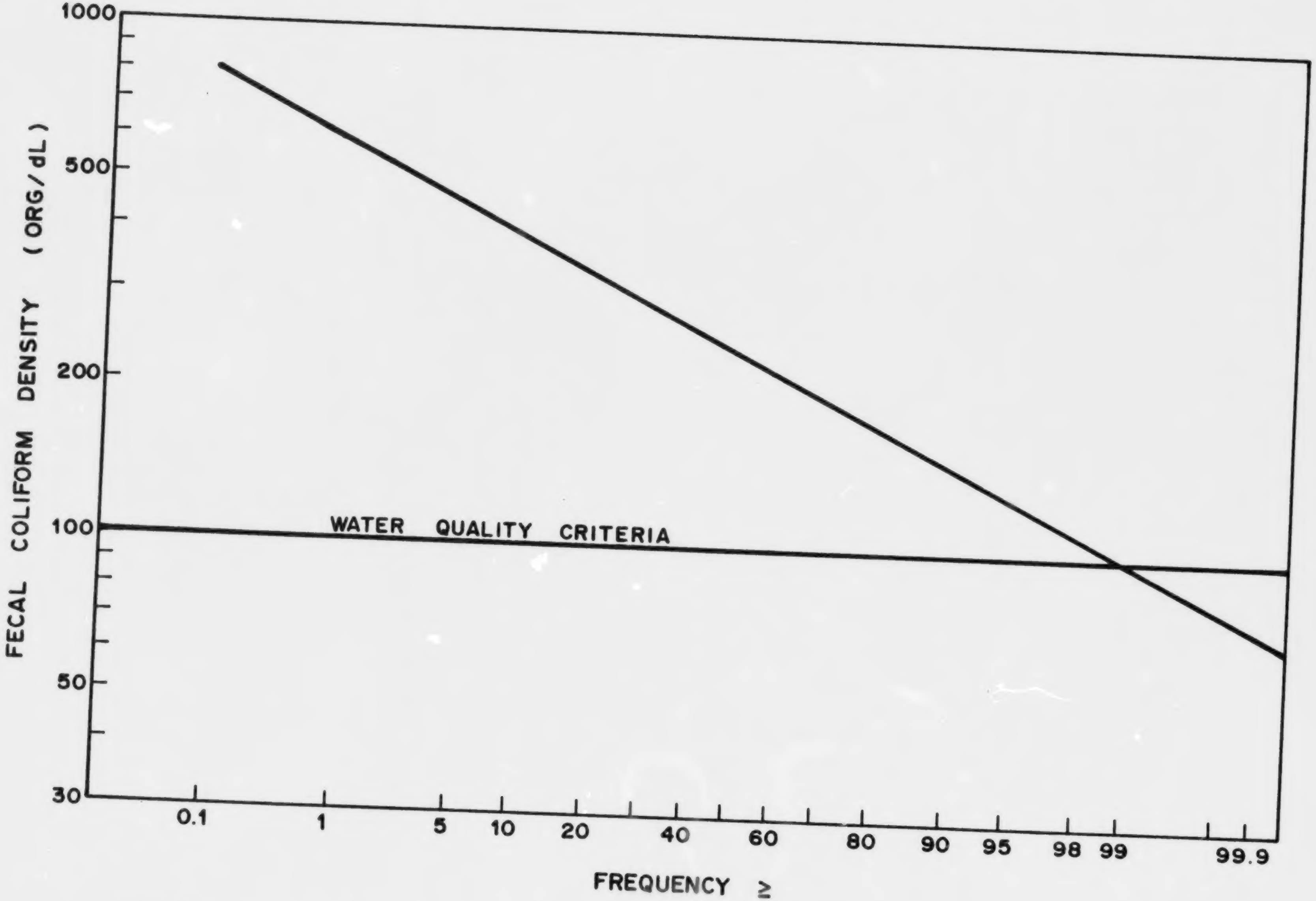


FIGURE 8-3 — DISTRIBUTION OF FECAL COLIFORMS AT BEACH AREA

TABLE 8-2. EVALUATION CRITERIA

Group	Weight		Criteria	Target Value
Water Quality	High	WQ1)	Elimination of untreated sewage discharges in dry weather	Zero Incidence
	High	WQ2)	Elimination of untreated sewage discharges in wet weather	Zero Incidence
	High	WQ3)	Exceedance frequency of fecal coliform densities of 100 org/dL	10%
Economic	High	E1)	Present value of abatement plan cost	Minimum
Equitable Distribution of Costs	High	D1)	$/person in communities A & B for control of common fecal coliform sources (i.e. dry weather intermittent and storm runoff)	None
Financial Feasibility	Medium	F1)	Ratio new debt/total debt for community A	None
	Medium	F2)	Ratio new debt/total debt for community B	None
Social Impacts	Low	S1)	Community disruption by construction activity associated with implementing alternative	None
Ease of Implementation	Low	I1)	Public acceptance of alternative plan	Minimize Opposition
Environmenal Impacts	Medium	EI1)	Impact upon natural environment of implementing alternative	Minimum

TABLE 8-3. CONTROL ALTERNATIVES FOR HYPOTHETICAL EXAMPLE

DRY WEATHER INTERMITTENT SOURCES	WET WEATHER BYPASS	STORM RUNOFF	IN-STREAM
1) Disconnection of cross-connections.	1) Storage and high rate disinfection at WPCP.	1) Street sweeping	1) Enhanced circulation of river water in the proximity of the beach areas. coupled with high rate disinfection of the circulated water (UV)
2) Build interceptor sewer connected to all outfalls leading to existing WPCP where treatment of dry weather flows would occur.	2) I/I reduction.	2) Build interceptor sewer connected to all outfalls and treat stormwater at 1) existing WPCP and 2) stormwater detention ponds fitted with high rate disinfection capability (e.g. UV reactor).	

ALTERNATIVE POLLUTION CONTROL PLANS

All of the proposed control alternatives specific to a given pollutant source with the exception of the interceptor pipe (for dry weather intermittens and storm runoff) are independent from each other (i.e. no tradeoffs exist). Given the MOH's criteria (no discharge of untreated sanitary wastes) the in-stream control alternative is also independent from both the wet weather bypass controls and the first control suggested for the dry weather intermittent sources (disconnection of cross-connections). Accordingly, the following groups of plans are developed in recognition of the above:

Plan A - Wet Weather Bypass Controls

Plan Number	Control Alternatives
A-1	Storage and high-rate treatment.
A-2	I/I reduction.
A-3	A-1 + A-2.

Plan B - Controls for Dry Weather Intermittent Sources and Storm Runoff

Plan Number	Control Alternatives
B-1	Disconnection of cross-connections + Street Sweeping + Enhanced circulation including disinfection
B-2	Dry/Wet Interceptor including runoff storage/treatment.
B-3	Disconnection + Enhanced circulation.
B-4	Dry/Wet Interceptor + Street Sweeping
B-5	Dry/Wet Interceptor + Enhanced circulation.

Other permutations and combinations are possible, however, for purposes of the example they are not considered.

Plan Evaluation

Plan A:

Based upon continuous simulation analysis, it was determined that Plan A3 (combination of Plans A1 and A2) would be most cost-effective. In this case, since other factors such as financial feasibility, social impact, etc. did not play a large part, it was possible to short-circuit the screening analysis and identify the "best" plan considering performance and cost only. The cost of Plan A3 was found to be $750 K which must be added to the cost of all other control measures required from community B. In this fashion, the total economic impact upon B can be gauged.

Plan B:

The results of the analysis of performance of the the B plans is presented in the matrix format in Table 8-4. Numerical values are used wherever possible, however, more subjective evaluations assessing social and environmental impacts and ease of implementation are also included. Each of the plans is then ranked for each evaluation criteria taken one at a time. The same ranking is given for equal values. Table 8-5 presents the rankings for the case study.

Finally, each of the plans are compared in a pairwise fashion and the dominant plan (best) of a pair goes on to be tested against the next plan while the poorer plan of the pair is discarded. The pairwise comparisons are continued until the overall best plan is identified. Table 8-6 presents the dominance testing in four pairwise comparisons which result in the selection of plan B-3.

TABLE 8-4. ASSESSMENT MATRIX FOR CASE STUDY

ALTERNATIVE	HIGH				MEDIUM			LOW	
	DRY WEATHER DISCHARGE	FREQUENCY OF EXCEEDENCE 100 org/dL	P.V. TOTAL COSTS $K	EQUITY $/person	FINANCIAL (1) FEASIBILITY A	FINANCIAL (1) FEASIBILITY B	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	EASE OF IMPLEMENTATION
B-1	None	5%	$ 750	A = $25 B = $67	.045	.023	V. Low	Med	High
B-2	None	10%	$3,000	A = $100 B = $26.7	.180	.090	High	Med	Med
B-3	None	7%	$ 650	A = $21 B = $5.9	.038	.020	V. Low	Low	High
B-4	None	9%	$3,100	A = $102 B = $27.7	.184	.094	High	Med	Med
B-5	None	3%	$3,400	A = $115	.210	.101	High	Med	Med

(1) Ratio $\frac{\text{New Debt}}{\text{Total Debt}}$

TABLE 8-5. RANKINGS FOR CASE STUDY

ALTERNATIVE	HIGH				MEDIUM			LOW	
	DRY WEATHER DISCHARGE	FREQUENCY OF EXCEEDENCE 100 org/dL	P.V. TOTAL COSTS $K	EQUITY $/person	FINANCIAL FEASIBILITY A	FINANCIAL FEASIBILITY B	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	EASE OF IMPLEMENTATION
B-1	1	2	2	2	2	2	1	2	1
B-2	1	5	3	2	3	3	2	2	2
B-3	1	3	1	1	1	1	1	1	1
B-4	1	4	4	2	4	4	2	2	2
B-5	1	1	5	3	5	5	2	2	2

TABLE 8-6. DOMINANCE EVALUATION FOR CASE STUDY

	ALTERNATIVE	HIGH				MEDIUM			LOW	
		DRY WEATHER DISCHARGE	FREQUENCY OF EXCEEDENCE (100 org/dL)	P.V. TOTAL COSTS ($K)	EQUITY ($/ person)	FINANCIAL FEASIBILITY A	FINANCIAL FEASIBILITY B	ENVIRONMENTAL IMPACT	SOCIAL IMPACT	EASE OF IMPLEMENTATION
First Pairwise Comparison	B-1	1.5	1	1	1.5	1.5	1	1	1.5	1
	B-2	1.5	2	2	1.5	1.5	2	2	1.5	2
	B-1 DOMINANT									
Second Pairwise Comparison	B-1	1.5	1	2	2	2	2	1.5	2	1.5
	B-3	1.5	2	1	1	1	1	1.5	1	1.5
	B-3 DOMINANT									
Third Pairwise Comparison	B-3	1.5	1	1	1	1	1	1	1	1
	B-4	1.5	2	2	2	2	2	2	2	2
	B-3 DOMINANT									
Fourth Pairwise Comparison	B-3	1.5	2	1	1	1	1	1	1	1
	B-5	1.5	1	2	2	2	2	2	2	2
	B-3 OVERALL DOMINANT									

Select Plan B-3

Disconnection of cross-connections plus enhanced in-stream circulation with disinfection.

CHAPTER 9

PCP SUMMARY REPORT

The output from PCP cursory assessment preparation will vary depending upon the amount and nature of data that is available or may be readily collected. If sufficient data is available, then the report format used for a cursory assessment will be the same as for a detailed assessment. If on the other hand, data at a cursory assessment level is insufficient to formulate a management plan(s), then the report will be interim in nature and possess a different format. The following subsections present suggested report formats for, i) a cursory assessment with sufficient data to develop, screen and specify a preferred management plan(s) or a detailed assessment, ii) a cursory assessment with insufficient data to specify a preferred management plan.

9.1 Report Format for a Complete Cursory Assessment or for a Detailed Assessment

The purpose of the report resulting from a complete cursory assessment or a detailed assessment is to document the problem analysis and to illustrate the rationale leading to the selection of the preferred management plan. The report should ideally contain the following:

- Problem description including a description of the study area.
- Statement of pollution control and other objectives.
- Description of evaluation criteria used for screening alternative management plans.
- Description of alternative management plans.
- Presentation of preferred management strategy including specifics of which party(s) will carry out the management actions.

Detailed technical analysis and detailed descriptions of control alternatives should be presented in the form of separate but subordinate technical reports or in the form of appendices to the report.

The complexity of the report will be in direct proportion to the nature of the water quality or other problems (e.g. basement flooding) requiring resolution and to the number of study participants (i.e. municipalities, government ministries and other agencies). It is therefore difficult to prescribe a single report format covering all eventualities. The following is a generalized report format which should be used only as a guide. The exact details of a particular report should be developed on a case specific basis. For a simple PCP with only a single municipality involved, the municipality should ensure reporting in a suitable format; where a multi-party PCP is required, the lead agency or designate should be responsible for proper reporting. The Ministry of the Environment through its Regions and Water Resources Branch should be contacted for assistance and advice.

PCP Summary Report

(complete Cursory Assessment or Detailed Assessment)

9.1.1 Title Page

- Indicate name of report, date and list participating agencies(1).

9.1.2 Preface

- Present overall study goal.
- Give description of study background including chronology of major events.
- Indicate participating agencies(1) and principal funding agency(s).
- Describe study management structure(1) and list persons serving on various committees in Appendix.

9.1.3 Summary and Recommendations

9.1.3.1 Summary

- Present brief description of study objectives.
- Present brief problem description including suitable discussion of study area, nature of water quality and other problems, problem sources and any unique aspects.
- Describe pollution control and other objectives and define evaluation criteria.
- Describe management plans.

Note: (1) May only be relevant to multi-party studies.

9.1.3.2 Recommendations

- Present major recommendations that make up the preferred management plan. Recommendations should be segregated by the nature of the management alternatives (i.e. remedial in-stream measures vs. end-of-pipe) and the pollutant source (e.g. urban storm runoff, agricultural, municipal drains). Some discussion should be included indicating the performance (e.g. degree of pollution control for specific water quality parameters) of the recommended alternative, its cost and any inter-relationships with other recommended controls.

9.1.4 Introduction

- Provide discussion of the background to the study.
- Provide rationale for the need for the PCP.
- Relationship to other studies (where appropriate).

9.1.5 Objectives

- Present overall study goal and specific study objectives (see Section 4.3 under sample terms of reference for example of specific study objectives).

9.1.6 Description of Study Area

(see Section 5.0 Cursory Assessment procedures for details)

- Present a synopsis of the major relevant features of the problem area. The synopsis may include the following:
  - Study area geographic location and boundaries.
  - Population and land-use data including the nature of industry and/or agricultural activity (present).
  - Description of storm, combined and sanitary sewerage facilities including sewer networks, and pumping and treatment facilities.
  - Description of receiving waters
- The above should be supported by suitable maps and charts in the main text and by more detailed technical appendices or supporting reports.

9.1.7 Problem Definition

Not all the elements listed below are always required for an adequate problem definition. Indeed, as is illustrated in the next chapter, it may be feasible to arrive at a management plan without engaging in an analysis of the receiving water. The following format should, therefore, be taken as a guide and only the aspects relevant and necessary to a given case should be included.

9.1.7.1 Water Resources

- A summary of water quality and, where appropriate, water quantity data, as well as any data relating to the quality of sediment and the pollutant concentrations found in aquatic organisms.
- The discussion in this section should lead to a problem definition specified in terms of Provincial Water Quality Objective violations. The discussion should also extend to the impact of water quality upon beneficial use.

9.1.7.2 Pollutant Source Analysis

- Provides best estimates (with or without field measurements and/or modelling) of the characteristics of all potentially significant pollutant sources in the study area under present and future conditions. The analysis should relate to the water quality problems identified in the water resources section of the problem definition chapter.
- Pollutant source analysis is interrelated with facilities analysis and other analyses such as:
  - land-use (present and future)
  - population (present and future)
  - sewage flows and I/I (present and future)
  - historical precipitation and snowmelt

  Depending upon the circumstances of a given PCP study these analyses may be included under the umbrella of the pollutant source assessment or be included as stand alone report sections.

9.1.7.3 Facilities Analysis

- Summarizes adequacy of relevant collection and treatment facilities under present and anticipated future conditions.
- Leads to definition of non-pollution control objectives (e.g. reduction in frequency of basement flooding).

9.1.7.4 Receiving Water Analysis

- Presents in so far as possible end-of-pipe criteria for pollutant sources based upon analysis of cause-effect relationship between sources and receiving water. These criteria represent pollution control objectives. If it is not possible to stipulate end-of-pipe criteria, this section should identify contribution to receiving water problems from the various pollutant sources.

All of the analyses making up the problem definition should be supported by details of methodology, validation data for models and summarized observations (either historical or present) presented in either technical appendices or separate but subordinate technical reports.

9.1.8 Pollution Control and Other Remedial Measures

- Provides summary description of major pollution control and other measures.
- Describes grouping of measures into alternative pollution control plans.

9.1.8.1 Evaluation Criteria

- Provides summary of criteria used to screen alternative management plans. Criteria are based on pollution control and other objectives, physical and institutional constraints and other criteria such as the direct environmental impact of controls, social disruption, etc.
- Gives weighting of individual criteria.

9.1.8.2 Plan Evaluation

- Presents matrix giving results of analysis of plan performance.
- Presents results of dominance testing giving preferred plan or plans.
- Presents summary of public reaction to recommendations.

9.1.8.3 Appendices

- Committee membership (if appropriate).
- Technical detail on all aspects presented in the body of the report.

9.2 Report Format for Cursory Assessment Resulting in a Recommendation for a Detailed Assessment

In some instances, it may not be possible to arrive at a completed pollution control plan with the information available at the cursory assessment level. Accordingly, the reporting format of the previous section will require modification. The exact format will again depend upon case specific circumstances. The following sets out some general guidelines for formatting cursory assessment reports of this type.

PCP Cursory Assessment Report

9.2.1 Title Page

(see Section 9.1)

9.2.2 Preface

(see Section 9.1)

9.2.3 Summary and Recommendations

9.2.3.1 Summary

- Present brief description of study objectives.
- Present (in so far as possible) brief problem description.

- Depending upon availability of data, present preliminary pollution control and other objectives and if possible suggest tentative evaluation criteria.
- Provide preliminary description (if possible) of potential controls and alternative management plans.

9.2.3.2 Recommendations

- Provide recommendations for interim pollution control measures (if possible and/or appropriate).
- Specify areas requiring detailed assessment.
- Indicate any required administrative changes or changes in participating agencies.

9.2.4 Introduction

(see Section 9.1.4)

9.2.5 Objectives

(see Section 9.1.5)

9.2.6 Description of Study Area

- Provide information indicated in Section 9.1.6 to extent possible.

9.2.7 Problem Definition

- Provides information and carryout analysis indicated in Section 9.1.7 to extent possible.
- Develops (if possible) tentative control objectives (pollution control and other).

9.2.8 Preliminary Analysis of Pollution Control and Other Remedial Measures

- Provides summary description of most promising control alternative and, if possible, groups alternatives into preliminary management plans.

9.2.9 Proposed Evaluation Criteria

- Provides summary of proposed evaluation criteria which may be subsequently used to screen management plans.

9.2.10 Detailed Assessment Requirements

- Identifies additional data needs and suggests requirements for further analysis.

9.2.11 Interim Control Measures

- Makes recommendations for interim control measures to be put into effect while detailed assessments are being carried out.

9.2.12 Appendices

- Revised PCP terms of reference incorporating changes indicated by detailed assessment requirements and incorporating any changes in administrative structure or participating agencies.
- Technical details of all aspects discussed in the main body of the report.

CHAPTER 10

PCP CASE STUDY

The following is a summary of studies carried out in Cornwall, Ontario and is intended to highlight the approach taken in developing a PCP. The example used here by no means follows exactly the format and content suggested for PCPs. Nevertheless, it serves as an interesting case study since it illustrates the interrelationship of facilities planning, municipal pollution control and industrial sewer-use.

The studies in Cornwall were by-in-large based upon analysis of historical data although a small field component was included to aid calibration of the STORM and SWMM models. In this sense, although sophisticated analysis techniques were employed, the study is termed an extended cursory assessment.

The bulk of the material that follows has been excepted from the City of Cornwall Report on Combined Sewer System Analysis (Gore and Storrie, 1980b). For the sake of consistency with remainder of this report, all quantities presented in imperial units have been converted to their metric equivalents.

10.1 Background

The City of Cornwall is situated adjacent to the St. Lawrence River approximately 32 kilometers west of the Ontario-Quebec border. In 1980, the city had a population of 46,000 persons.

The first sewers were constructed in Cornwall to service the growing development of the city over 100 years ago. A system of combined sewers was initially installed, receiving both sanitary wastes and stormwater runoff and discharging without treatment directly to the St. Lawrence River. The majority of the older sections of the city, including the downtown commercial core area and much of the surrounding residential development are serviced with combined sewers. Most developments serviced since the early 1960's, have separate storm and sanitary sewer networks although in some cases these sewers discharged to a common combined trunk sewer.

During the period 1964 to 1969, trunk sewers and a main intercepting sewer along the riverfront were constructed and placed into service. As well, a main sewage pumping station and primary treatment facility were completed at the terminus of the Riverfront interceptor.

At the time of the study, both the municipality and MOE held a number of concerns regarding the capacity and operation of the collection system and the water pollution control plant (WPCP). The major issues were as follows:

WPCP:

- The WPCP was initially designed for an average dry weather flow of 37,483 m^3/d. Since the plant was commissioned in 1969, average daily flows to the plant in the period 1969 to 1973 increased from 31,349 m^3/d to 49,977 m^3/d or approximately 60%. The plant was thus hydraulically overloaded allowing no scope for either industrial or residential growth.
- The primary WPCP at Cornwall exhibited very low removal efficiencies. In the years prior to the study, removals averaged 10% and 25%, respectively, for BOD_5 and suspended solids. The poor process performance was attributed to the combined effects of periodic hydraulic overloads and high strength industrial waste discharges (high soluble BOD). Provincial regulations at the time also required implementation of phosphorus removal to achieve a target effluent concentration of 1 mg/L total P.

Combined Sewer System:

- The main Cornwall intercepting sewer (Riverfront interceptor) was provided with 8 regulator chambers which permitted discharge of combined sewage to the St. Lawrence River. Combined sewage was routinely discharged at all of the regulators during periods of significant rainfall or snowmelt. Moreover, at two of the regulators, raw sewage discharges were found to occur even in dry weather.

  Concern was expressed by MOE regarding the impact of both dry and wet weather overflows upon near shore water quality in the St. Lawrence River. In particular, concern was expressed regarding a number of downstream bathing beaches. No rigorous cause-effect relationship had, however, been established between combined sewer overflow and bacterial densities in the vicinity of beach areas. The operation of other smaller flow structures discharging to local streams was not examined during the course of the study. It was felt that any problems associated with these discharges were of lesser priority and would be tackled at a later date.

Industrial Sewer-Use

- As already noted, the industrial component of sewage flow contained high strength wastes which exceeded the then current by-law limits.

10.2 Study Objectives

Based upon the concerns outlined in the previous section and other concerns, terms of reference were developed for the study. Only those aspects relevant to the items indicated in the previous section are listed below:

1. To assess the magnitude and frequency of storm waste loads to the receiving stream (St. Lawrence River).
2. To estimate the efficiencies of wet weather vs. dry weather treatment in meeting environmental quality objectives.
3. To estimate the storage or treatment capacity required to achieve a given level of pollution control of wet weather discharge.
4. To indicate the most effective combination of options to achieve environmental objectives.
5. To investigate alternatives to the proposed sewage treatment expansion, which may reduce the amount of capital expenditure required.

10.3 Description of the Study Area

10.3.1 Description of Sewer System

The layout of the sewer system is presented schematically in Figure 10.1. Reference should be made to the original report for details of sewer size and tributary area characteristics. The most relevant features of the sewer system and tributary area are summarized below.

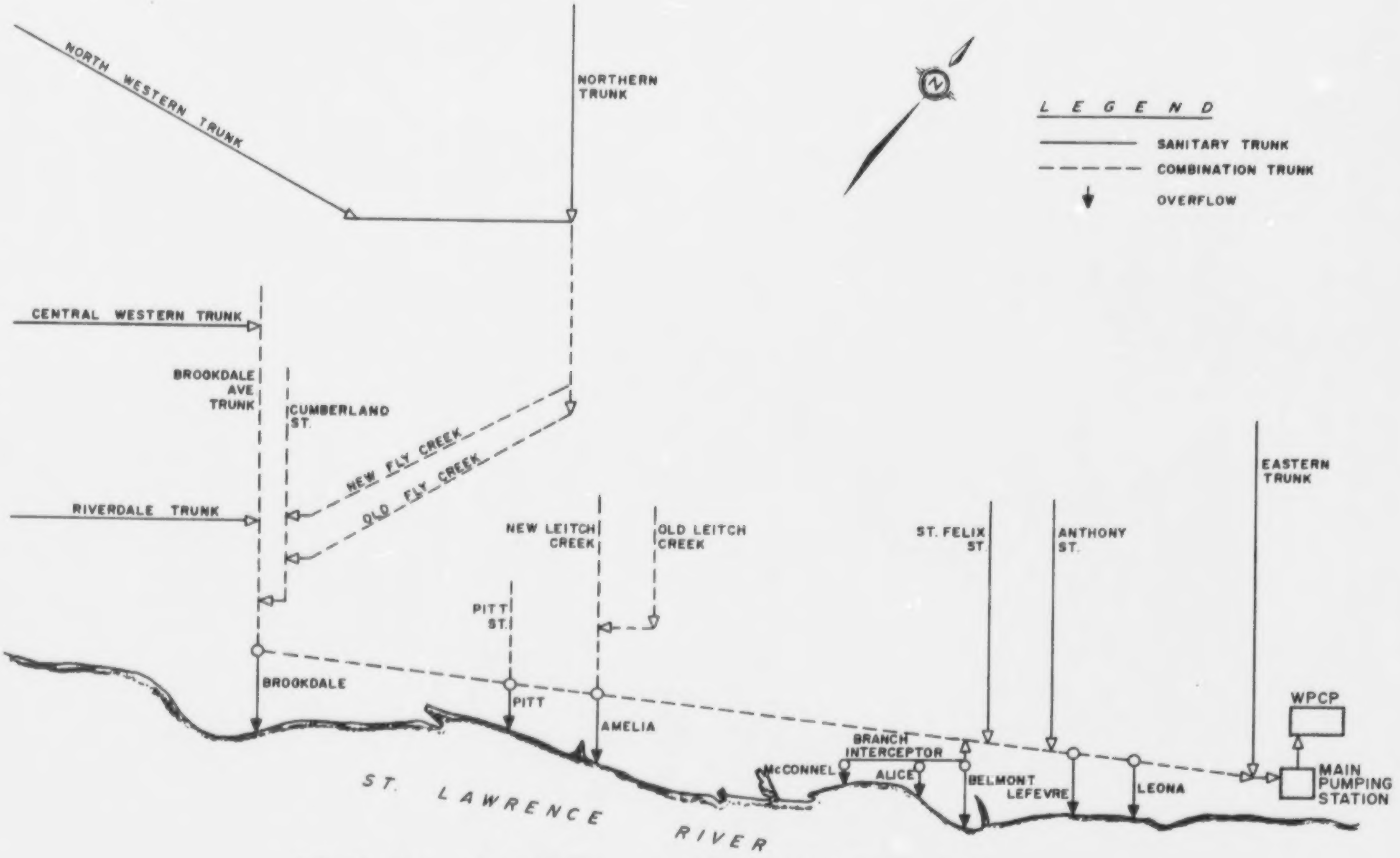

NORTH WESTERN TRUNK
NORTHERN TRUNK
LEGEND
SANITARY TRUNK
COMBINATION TRUNK
OVERFLOW
N
CENTRAL WESTERN TRUNK
BROOKDALE AVE TRUNK
CUMBERLAND ST.
NEW FLY CREEK
OLD FLY CREEK
RIVERDALE TRUNK
NEW LEITCH CREEK
OLD LEITCH CREEK
PITT ST.
ST. FELIX ST.
ANTHONY ST.
EASTERN TRUNK
BROOKDALE
PITT
AMELIA
BRANCH INTERCEPTOR
McCONNEL
ALICE
BELMONT
LEFEVRE
LEONA
WPCP
MAIN PUMPING STATION
ST. LAWRENCE RIVER

FIGURE 10-1 — SCHEMATIC OF CORNWALL SEWER SYSTEM

i) Serviced Area

The serviced area with the City of Cornwall at the time of the study was comprised of the following areas:

a) combined sewer area - 496 ha
b) separate sanitary area - 998 ha
c) undeveloped area contributing storm drainage to combined sewers - 119 ha
d) separate sanitary area contributing storm and sanitary flows to combined sewers - 107 ha

1720 ha

ii) Riverfront Interceptor

The Riverfront interceptor extends from Brookdale Avenue, easterly to the main sewage pumping at the east end of the city. The interceptor is 5212 m in length and has a diameter of 1676 mm. The theoretical flow capacity of the interceptor is 199,909 m^3/d.
The Riverfront interceptor sewer received flow from a contributory drainage area of approximately 1483 ha of which 994 ha or 67% is contributed through the Brookdale Avenue sewer.

iii) Regulators

Flow is intercepted from the combined trunk to the Riverfront interceptor through various regulator chambers, located as follows:

1. Brookdale Avenue
2. Pitt Street
3. Amelia Avenue
4. McConnell Avenue
5. Prince Arthur Street) combined in one
6. Louisa Avenue) overflow to
7. Alice Street) St. Lawrence River
8. Bellmont Street
9. Lefebvre Avenue
10. Leonia Street

The amount of flow intercepted at the Brookdale Chamber is regulated by means of a motorized gate, remotely controlled from the water pollution control plant.

The remainder of the regulator chambers are equipped with orifice pipe connections, to divert peak sanitary flow rates to the interceptor. During periods of storm events or spring runoff, flows in excess of the regulator capacity are diverted over a weir and through overflow sewers directly to the St. Lawrence River.

The regulator chambers were hydraulically designed to intercept two and one-half times dry weather flow from each of the tributary areas, to be diverted into the Riverfront intercepting sewer.

Experience has shown over the course of the recent years, and it has been witnessed as part of this study, that overflow to the St. Lawrence River occurs under dry weather flow conditions, at:

- Pitt Street
- Amelia Street

These two interceptor chambers receive the flow from the majority of the downtown commercial area, where experience has shown that water cooled air conditioners are used extensively. This was not accounted for in the original design of these interceptor chambers and may have accounted in part for the high flows from these areas.

10.3.2 Main Sewage Pumping Station and Water Pollution Control Plant

Pumping Station

Flow enters the station uncontrolled, through the inlet chamber and bar screen, to the pumping station wet well. Control of the water level within the wet well is maintained by manipulating the control gate at the Brookdale regulator chamber.

The pumped station is equipped with four sewage pumps with a hydraulic capacity of 113,585 m^3/d.

Water Pollution Control Plant

The Water Pollution Control Plant was designed to provide primary treatment for the contributory average dry weather flow of 37,483

m^3/d from the City of Cornwall. The hydraulic capacity of the plant is 2.5 x average DWF, or 93,730 m^3/d. The main components of the plant consist of:

Screening - 2 Barminutors
Grit Removal - 2 aerated tanks
- volume - 216 m^3 each
- detention time - 16.6 min. (at design flow)

Primary Settling - 2 tanks
- type - rectangular
- volume - 2460 m^3 each
- detention time - 3.2 hrs. (at design flow)
- overflow rate - 28 $m^3/m^2.d$

Chlorination - 1 tank
- volume - 365 m^3
- detention time - 14 min. (at design flow)

Details relating to the design data for both the main sewage pumping station and the Water Pollution Control Plant are included in Appendix A and Appendix B to the 1975 "Design Report on the Expansion of the Cornwall Water Pollution Control Plant" (Gore and Storrie, 1975).

10.3.3 Population and Industry

Population

In the years following the construction of the WPCP in 1965 until the time of study in 1978, the population in Cornwall remained relatively stable experiencing slight growth in the years 1977 and 1978.

Anticipated growth rates to the end of the planning period in the year 2001 are also modest. It was expected that population growth would occur at a rate of about 0.5%. Figure 10-2 presents the historical and projected population data for the period 1969 to 2001.

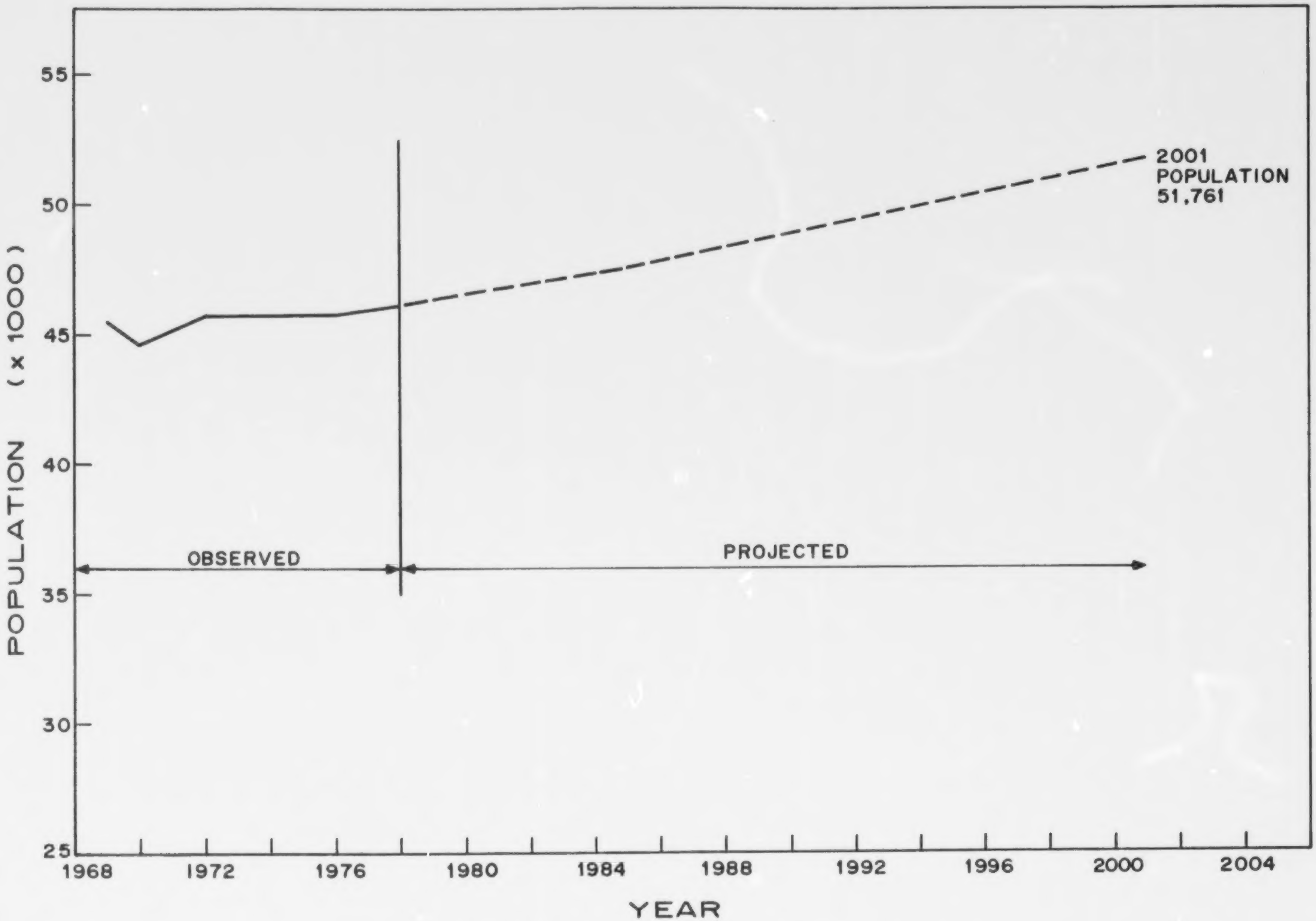


FIGURE 10-2 — CITY OF CORNWALL POPULATION GROWTH

Industry

Although the population had remained stable during the 1969 to 1978 period, Cornwall did experience growth in industry. At the time of the study, it was estimated that industry contributed about 8% (4,089 m^3/d) of the average daily flows.

Many of the major water using industries discharged flows directly to the St. Lawrence River. The major industrial discharges connected to the WPCP are listed in Table 10-1 by category and/or product.

TABLE 10-1. MAJOR CORNWALL INDUSTRIES DISCHARGING TO SANITARY OR COMBINED SEWERAGE

INDUSTRY CATEGORY	PRODUCTS
Food Processing	whey powder and lactose
Inorganic Chemicals	acetic acid, sodium citrate
Organic Chemicals	phthalic anhydride, phthalic acid esters plasticisers
Construction Materials	fibreboard

10.4 Problem Definition

In the Cornwall study, the purpose of the problem definition was to develop a more specific understanding of the characteristics and underlying causes of the problems previously described in the background section.

The problem definition consisted chiefly of an evaluation of dry and wet weather flows and pollutant loads, their sources and the ability of the existing sewerage and WPCP facility to accommodate these flows and loads. As well, the impact of future growth upon the flow and pollutant quantities was examined.

The output of this exercise enabled performance objectives to be developed as well as the identification of promising potential management plans. The following subsections will present the major findings of the dry and wet weather analysis. For details of study methods, reference should be made to the original study report.

10.4.1 Dry Weather Flow Analysis

An analysis of dry weather flow quantities was carried out for flows observed at the WPCP and at a number of locations within sewerage. The objectives of this analysis were as follows:

WPCP

i) To establish the time history of flows at the WPCP and to estimate future flow quantities to the end of the planning period (2001).

ii) To evaluate the magnitude of the individual dry weather flow components (i.e. residential/commercial, industrial, dry weather infiltration).

iii) To estimate the dry weather loading of selected pollutants reaching the existing WPCP.

Combined Sewerage

i) To estimate dry weather flow quantities at various locations within the combined sewer network in particular at combined sewer regulators under present and future conditions. (This data was needed to aid in the calibration of the STORM model which was the principal tool used for the analysis of combined sewer overflows and separate stormwater runoff.)

ii) To estimate dry weather flow quality at the Brookdale Regulator and other selected regulators. (This data was again necessary for STORM estimates.)

Only selected results are presented here to illustrate the analyses performed. Reference should be made to the original report for additional results.

WPCP Flow Quantity

Table 10-2 presents the analysis of historical flows observed at the WPCP. The data suggests a heavily infiltrated system.
Based upon this data, flow projections were made in consideration of a 20 year planning horizon and the population estimates indica-

TABLE 10-2. HISTORICAL WPCP DATA FLOW

	YEAR						COMPUTATION
	1975	1976	1977	1978	1979	AVG.	
Population	47,743	45,689	46,087	46,152	46,000	45,934	--
1) Observed Total Flow (wet + dry) m^3/d	47,726	50,454	55,453	50,454	48,635	45,934	--
2) Observed Dry Weather Flow m^3/d	42,726	40,726	47,499	44,363	41,363	43,336	--
3) Wet Weather Flow Component m^3/d	5,000	9,727	7,954	6,091	7,273	7,209	= (1)-(2)
4) Residential/Commercial Wastewater Production m^3/d	12,500	12,454	12,591	12,591	12,545	12,536	--
5) Industrial Wastewater Production m^3/d	2,409	2,409	1,954	1,954	1,954	2,136	--
6) Dry Weather Infiltration m^3/d	27,817	25,863	32,954	29,817	26,863	28,663	= (2)-(4)-(5)
7) Total Capita Flow lpcd	1,043	1,104	1,203	1,093	1,057	1,100	$= \frac{(1)}{\text{Population}}$
8) Dry Weather Per Capita Flow lpcd	930	890	1,030	960	900	940	$= \frac{(2)}{\text{Population}}$
9) Dry Weather Per Capita Infiltration lpcd	610	570	720	650	580	620	$= \frac{(6)}{\text{Population}}$

ted in Figure 10-2. It was assumed in making the projections that new sewers would not suffer a similar degree of dry weather infiltration. Hence, a dry weather per capita flow of 681 lpcd was selected as more reflecting future growth. Future dry weather flow in the year 2001 was accordingly estimated as 54,480 m^3/d with a peak daily flow estimated as 1.33 x 54,480* or 72,458 m^3/d. Any expansion of primary treatment facilities would need to accommodate the 20 year peak rate.

In-Sewer Flow Quantity

An assessment of dry weather flows at various locations including the flows tributary to the Brookdale Regulator was also carried out but is not presented here. The purpose of this assessment was principally as input to subsequent simulation modelling by STORM or SWMM. It should, however, be noted that flow and quality data collection was achieved through a field program.

Dry Weather Sewage Quality

Dry weather sewage quality and pollutant loadings at the WPCP, at locations within the sewer system and at the point of entry into the sewerage system from major industries are presented in Table 10-3. It is readily apparent from the table that the industrial contribution of certain pollutants (e.g. BOD) is quite significant, exceeding 60% of the annual total load in the WPCP influent. The influence of industrial wastes can be seen by comparing sewage quality at Brookdale which has a heavily industrialized tributary area with flows at Augustus which serves a residential area.
This data suggested that industrial sewer-use controls mights well be beneficial in reducing total loadings to the St. Lawrence River.

10.4.2 Wet Weather Flow Analysis

The basic objectives of the wet weather analysis were as follows:

- Estimate total runoff volumes and total combined sewage volumes annually discharged.

Note: * Reference should be made to the original report for details regarding estimation of peak flows.

TABLE 10-3. DRY WEATHER SEWAGE QUALITY AND POLLUTANT LOADINGS

IN-SEWER LOCATIONS

LOCATION/ INDUSTRY	POLLUTANT CONCENTRATION			AVERAGE DAILY	ANNUAL POLLUTANT LOADING		
	SS (mg/L)	BOD (mg/L)	TOTAL-P (mg/L)	DWF (m^3/d)	SS 10^5/kg	BOD 10^5/kg	TOTAL-P 10^5/kg
WPCP Influent	161	135	3.9	43,180	25.31	21.23	0.06
DWF Brookdale Regulator	253	102	N.D.	24,317	22.41	9.03	-
DWF Augustus St.	34	20	N.D.	-	-	-	-

INDUSTRY LOCATIONS

LOCATION/ INDUSTRY	POLLUTANT CONCENTRATION			AVERAGE DAILY	ANNUAL POLLUTANT LOADING		
	SS (mg/L)	BOD (mg/L)	TOTAL-P (mg/L)	DWF (m^3/d)	SS 10^5/kg	BOD 10^5/kg	TOTAL-P 10^5/kg
Industry							
A	300	1,500	37	1,045	0.34	0.40	0.10
B	1,500	6,000	16	545	2.08	8.35	0.02
C	300	1,200	7	227	0.17	0.69	-
D	180	150	4	122	0.05	0.05	-
E	180	150	4	4	-	-	-
TOTAL LOADING/FLOW	--	--	--	1,943	2.64	9.49	0.13

- Estimate total overflow volumes and pollutant loads annually discharged.
- Estimate total loadings and volumes (WPCP effluent and wet weather) annually discharged.
- Estimate annual and seasonal overflow frequencies at various combined sewer regulators.
- Provide a framework which could be subsequently employed for the analysis of management plan performance.

Prior to initiating this analysis, evaluation of the regulators was carried out with a view to examining which structures could safely be closed. Based upon this evaluation, it was determined that all regulators with the exception of Brookdale Avenue and Pitt and Amelia Streets could be eliminated. As a consequence, the wet weather analysis focused upon these three sites.

In the original report, the wet weather and total volume and loading analysis was not separately abstracted and presented. Rather the existing conditions were included in various figures and tables as a baseline condition. Accordingly, the details of results of the wet weather analysis are included in the subsequent section dealing with the evaluation of the alternative management plans. Only a summary of wet weather flows, loadings and frequencies under existing conditions is presented here in Table 10-4. The data does, however, serve to illustrate that the Cornwall system overflowed with virtually every rainfall event producing runoff. In the case of Pitt Street, dry weather overflows are also included.

TABLE 10-4. WET WEATHER FLOWS AND LOADINGS (EXISTING CONDITIONS)

SYSTEM LOCATION	TYPE OF EFFLUENT	NO. OF EVENTS	TOTAL ANNUAL DISCHARGE			
			FLOW $m^3 \times 10^5$	SS kg $\times 10^5$	BOD_5 kg $\times 10^5$	TOTAL P kg $\times 10^5$
Cornwall(1) Catchment	Runoff & C.S.O.	50	7.7	.776	1.385	0.025
Pitt St. Overflow	C.S.O.	80	0.62	--	--	--
Amelia St. Overflow	C.S.O.	50	0.60	--	--	--
WPCP (Wet & Dry)	Effluent	--	176.8	33.75	22.48	0.77

Note: (1) Includes Pitt and Amelia overflows.

10.5 Performance Objectives and Evaluation Criteria

The major concern associated with Cornwall combined sewer overflows was the potential contamination of downstream beaches. However, as no concrete cause-effect relationship between C.S.O. and receiver impacts had been established, performance objectives with respect to C.S.O. were somewhat vague and tended toward a minimization of overflow frequency and volume in the summer period. The pursuit of these objectives was further tempered by a desire to implement controls quickly and to prescribe measures which the municipality could afford. Moreover, any alternatives would need to meet WPCP capacity requirements for the 2001 population (or industrial equivalent) and need to meet MOE requirements regarding treatment efficiency and phosphorus removal. The favoured management plans tended towards use of existing storage and expanded treatment coupled with regulator consolidation (reduction in the total number of regulators) and measures such as industrial sewer-use controls and enhanced street sweeping. No serious consideration was given to I/I reduction.

Table 10-5 gives the listing of the performance objective statements resulting from the above considerations.

TABLE 10-5. CORNWALL CASE STUDY PERFORMANCE OBJECTIVES

COMBINED SEWERAGE	WPCP	INDUSTRY
-Consolidation of overflow sites into the smallest number possible. -Minimize overflow frequencies, volumes and loads at remaining overflows (particularly during summer June - September season).	-Provide sufficient capacity to treat 2001 flow (20 year design). -Total P - 1.0 mg/L (implement P-removal). -*BOD_5 - 50% removal -*SS - 70% removal *with chemical P-removal	-Reduce industrial effluent concentrations to within by-law limits.

In developing the evaluation criteria, the performance objectives were adopted as a whole. However, other considerations such as capital cost, implementation feasibility (e.g. availability of land) were also included in these criteria. Direct environmental impacts of implementing alternatives, financial impacts or operating costs were not considered.

10.6 Formulation and Evaluation of Management Plans

A total of 12 alternative management schemes were developed to meet the performance objectives. The plans included:

i) Various combinations of storage and WPCP treatment capacity to reduce combined sewer overflows.

ii) Various degrees of industrial control ranging from none to elimination of industrial flows. The middle alternative was strict enforcement of industrial by-law limits.

iii) Street sweeping to reduce the pollutant load found in the runoff originating from either combined sewer overflow or separated storm runoff.

Table 10-6 lists the management alternatives and presents volume and loading data including the annual runoff loads. Runoff loadings entered into consideration since storage alternatives would give some measure of control over these loads. It should be noted, however, that runoff loadings per se were not an issue in this study.

The storage/treatment alternatives with and without supplemental street sweeping and industrial controls were the only measures that could meet both the WPCP and combined sewer objectives. The most attractive alternative appeared to be utilization of the existing storage capacity available in the Riverfront Interceptor sewer along with some combination of treatment and pumping capacity at the WPCP.

Alternative 8 emerged as the favoured approach because it met two of three performance objectives at what was felt to be minimum cost. Since specific levels of wet weather control had not been stipulated, it was argued that this alternative provided a solution that could be implemented in the short term with a minimum financial impact on the municipality. Industrial controls and enhanced street sweeping while providing benefits were felt to be of low immediate implementation feasibility and hence were not promoted. Similarily, reduction of flows through a dry weather I/I program while desirable was felt to require a long term effort.

Not shown but implicit in alternative 8 are two additional aspects as follows:

i) Implementation of phosphorus control through chemical coagulation at the WPCP.

ii) Increase in the interception capacity of the Pitt and Amelia regulators which would eliminate dry weather overflows as well as reducing significantly wet weather overflows.

Further analysis of the storage/treatment alternatives was carried out to evaluate the performance and costs of these alternatives and establish the degree of control feasible with alternative 8.

TABLE 10-6. COMPARISON LISTING OF CONTROL ALTERNATIVES

STORM WATER MANAGEMENT CONTROL SCHEME	TOTAL ANNUAL LOADING (FROM WATERSHED)				OVERFLOW - ANNUAL LOADING					FLOW TO W.P.C.P.				W.P.C.P. - EFFLUENT DISCHARGE				NET LOAD TO RIVER				% REDUCTION FROM PRESENT SYSTEM		
	FLOW	S.S.	BOD	TOTAL-P	FLOW		S.S.	BOD	TOTAL-P	FLOW	S.S.	BOD	TOTAL-P	FLOW	S.S.	BOD	TOTAL-P	FLOW	S.S.	BOD	TOTAL-P	S.S.	BOD	TOTAL-P
	$m^3 \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$m^3 \times 10^6$	NO. OF EVENTS	$kg \times 10^3$	$kg \times 10^3$	$kg \times 10^3$	$m^3 \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$m^3 \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$m^3 \times 10^6$	$kg \times 10^6$	$kg \times 10^6$	$kg \times 10^6$			
1. Present System	184.5	3.44	2.38	.079	7.7	50	77.4	138.2	2.54	176.8	3.38	2.25	.77	176.8	(25%) 2.52	(10%) 2.02	(20%) .06	184.5	2.60	2.16	.06	—	—	—
2. Plant Expansion - 109,000 m^3/d Treatment and Hydraulic	184.5	3.44	2.38	.079	7.7	50	77.4	138.2	2.54	176.8	3.38	2.25	.77	176.8	(80%) .67	(30%) 1.57	(80%) .02	184.5	.75	1.71	.02	71	21	72
3. Plant Expansion - 163,000 m^3/d	184.5	3.44	2.38	.079	4.7	33	50.5	81.3	1.51	179.8	3.40	2.31	.78	179.8	(80%) .68	(30%) 1.61	(80%) .02	184.5	.73	1.53	.02	72	29	74
4. Use of Existing Trunk Sewer * Storage	184.5	3.44	2.38	.079	4.7	19	39.8	52.3	1.04	179.7	3.41	2.34	.78	179.7	(25%) 2.55	(10%) 2.10	(20%) .06	184.5	2.59	2.15	.06	0.4	0.4	0.4
5. Improved Street Sweeping	184.5	3.39	2.23	.076	7.7	49	49.9	86.6	1.69	176.8	3.35	2.14	.74	176.8	(25%) 2.51	(10%) 1.92	(20%) .06	184.5	2.56	2.01	.06	2	7	4
6. Industrial Flow Eliminated	168.7	1.80	1.14	.047	7.4	49	63.2	123.5	2.23	161.3	1.74	1.02	.45	161.3	(25%) 1.30	(10%) .91	(20%) .04	168.7	1.40	1.04	.04	48	52	40
7. Industrial Flow @ Bylaw Limits	184.5	2.35	1.61	.079	7.7	49	68.8	130.9	2.54	176.8	2.29	1.48	.08	(25%) 176.8	(10%) 1.71	(20%) 1.33	.06	184.5	1.78	1.46	.06	32	32	—
8. Plant Expansion 109,000 m^3/d + Storage in Existing Trunk	184.5	3.44	2.38	.079	4.7	19	39.8	52.3	1.04	179.7	3.41	2.34	.79	(80%) 179.7	(30%) .68	(80%) 1.63	.02	184.5	.72	1.68	.02	72	22	74
9. Plant Expansion 109,000 m^3/d + Storage in Existing Trunk + Improved Street Sweeping	184.5	3.39	2.23	.076	4.7	19	23.9	33.9	.72	179.7	3.38	2.19	.75	(80%) 179.7	(30%) .67	(80%) 1.53	.01	184.5	.70	1.55	.02	73	28	75
10. Plant Expansion 109,000 m^3/d + Storage in Existing Trunk + Improved Street Sweeping + Industrial Flow @ Bylaw Limits	184.5	2.31	1.46	.076	4.7	19	19.3	30.7	.72	179.7	2.30	1.42	.75	(80%) 179.7	(30%) .46	(80%) .99	.01	184.5	.48	1.02	.02	82	53	75
11. Plant Expansion 163,000 m^3/d + Storage in Existing Trunk	184.5	3.44	2.38	.079	2.6	15	23.9	28.5	.57	181.9	3.43	2.35	.79	(80%) 181.9	(30%) .68	(80%) 1.65	.02	184.5	.71	1.68	.02	73	22	74
12. Plant Expansion 163,000 m^3/d + Storage in Existing Trunk + Improved Street Sweeping	184.5	3.39	2.23	.076	2.6	15	1.32	17.9	.38	181.9	3.39	2.21	.76	(80%) 181.9	(30%) .68	(80%) 1.54	.01	184.5	.69	1.56	.02	74	28	76
13. Plant Expansion 163,000 m^3/d + Storage in Existing Trunk + Improved Street Sweeping + Industrial Flow @ Bylaw Limits	184.5	2.31	1.45	.076	2.6	15	5.2	16.3	.72	181.9	2.31	1.44	.75	(80%) 181.9	(30%) .46	(80%) 1.00	.01	184.5	.47	1.02	.02	82	53	76

Note: (%) Signifies Plant Efficiency.

* Storage in Existing Sewer = 355,000 m^3 to elev. 157.4.

The degree of runoff control (which was equated to the degree of combined sewage control) for various levels of storage and treatment is presented in Figure 10-3 for the then current dry weather flow (5 year average). The degree of control achieved with the maximum utilization of interceptor storage and a treatment rate of 109,000 m^3/d (alternative 8) is indicated by the small circle. The impact of increased dry weather flow (future population conditions) was also examined. Figure 10-3 was redrawn with a dry weather flow of 54,500 m^3/d and is presented in Figure 10-4. The degree of runoff control has dropped by approximately 10% because of the increase.

Alternative 8 (109,000 m^3/d treatment and maximum inceptor storage ≈10,000 m^3) was further evaluated to assess the number of overflows and overflow volumes resulting at present and future dry weather conditions. The results of this analysis are presented in Figure 10-5. Overflow volumes and frequencies are evaluated with respect to the summer season and the remainder of the year.

Under present dry weather flow conditions of approximately 43,000 m^3/d, the analysis indicates about 20 overflows per year or about a 60% reduction from the then present frequency. The overflows are equally divided between the summer and remaining seasons. With the anticipated increase in flows (≈ 54,000 m^3/d) in the period to 2001, the overflow frequency would increase marginally to 23 events per year, unless other measures were implemented.

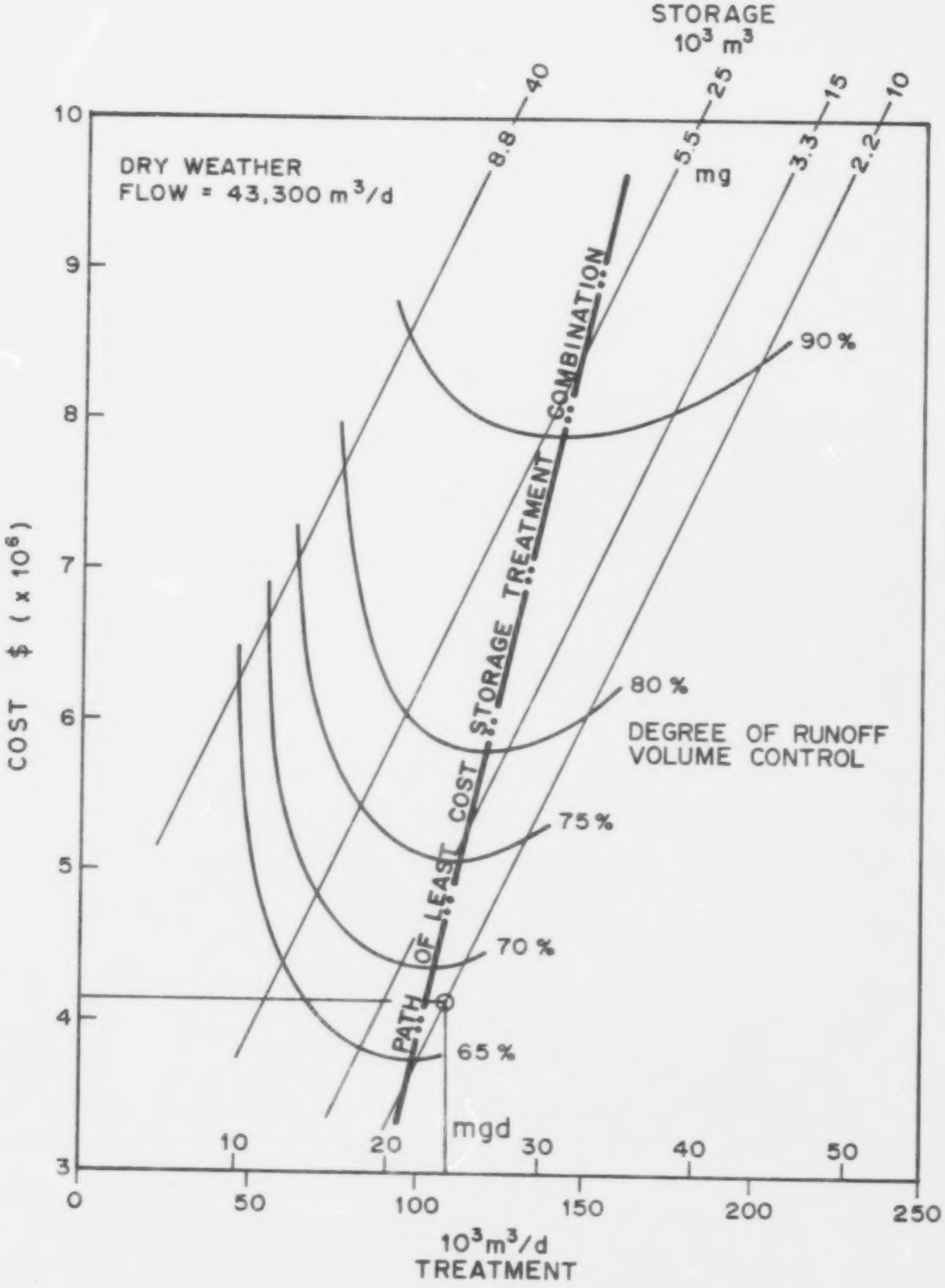
10.7 Recommendations and Costs

10.7.1 Recommendations

Based upon the previous analyses, the following recommendations were made. The original report contains other conclusions and recommendations that are not germane to the present discussion and are therefore not included.

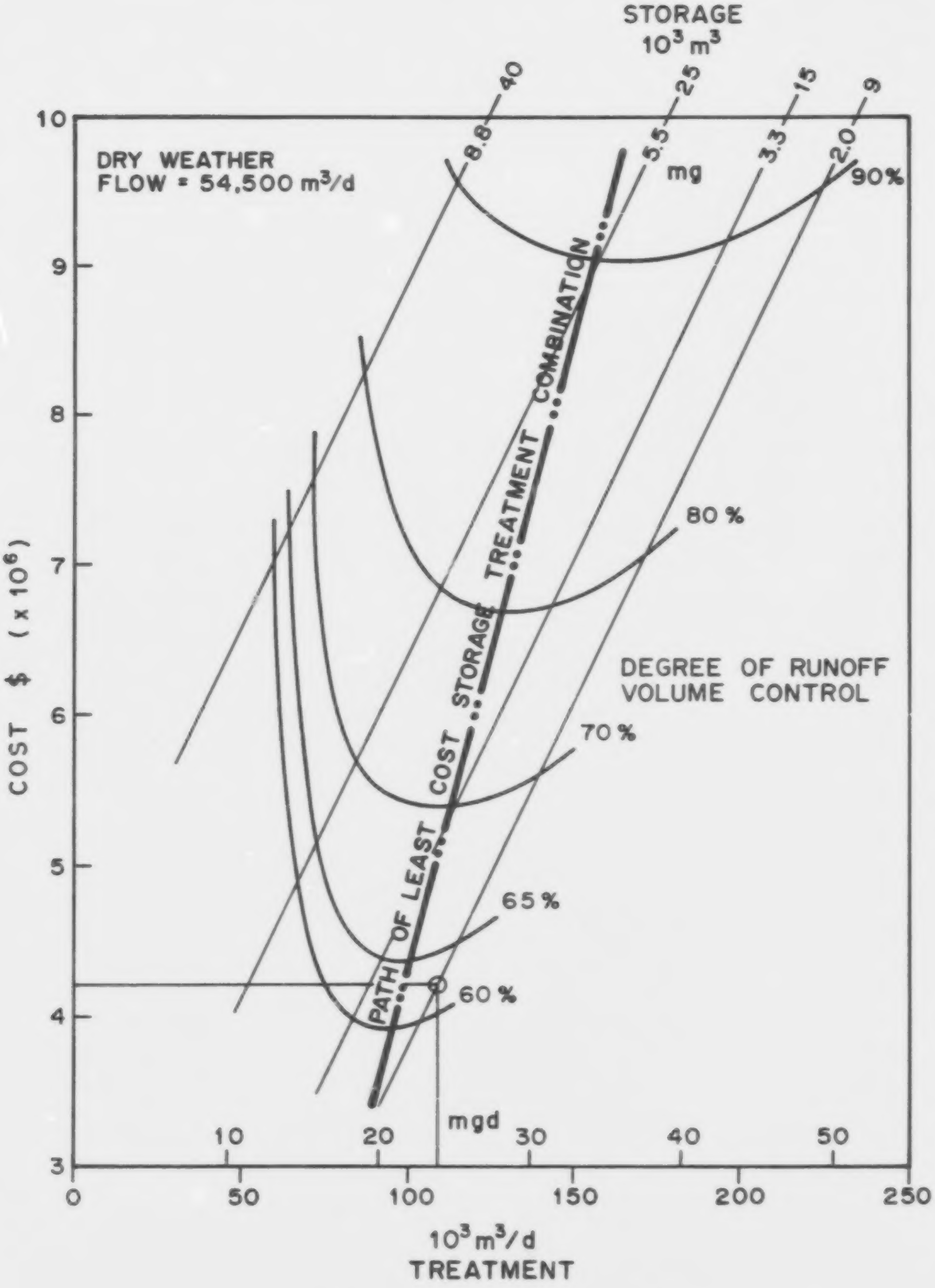
Sewage Flows

A major factor leading to the undertaking of this study and report, relates to the continuously increasing rates of flow to the Water Pollution Control Plant, particularly throughout the period 1969 to 1973.



CITY OF CORNWALL

FIGURE 10-3 — STORAGE TREATMENT COMBINATION
PRESENT FLOW EFFECTIVENESS



CITY OF CORNWALL

FIGURE 10-4 — STORAGE TREATMENT COMBINATION FUTURE FLOW EFFECTIVENESS

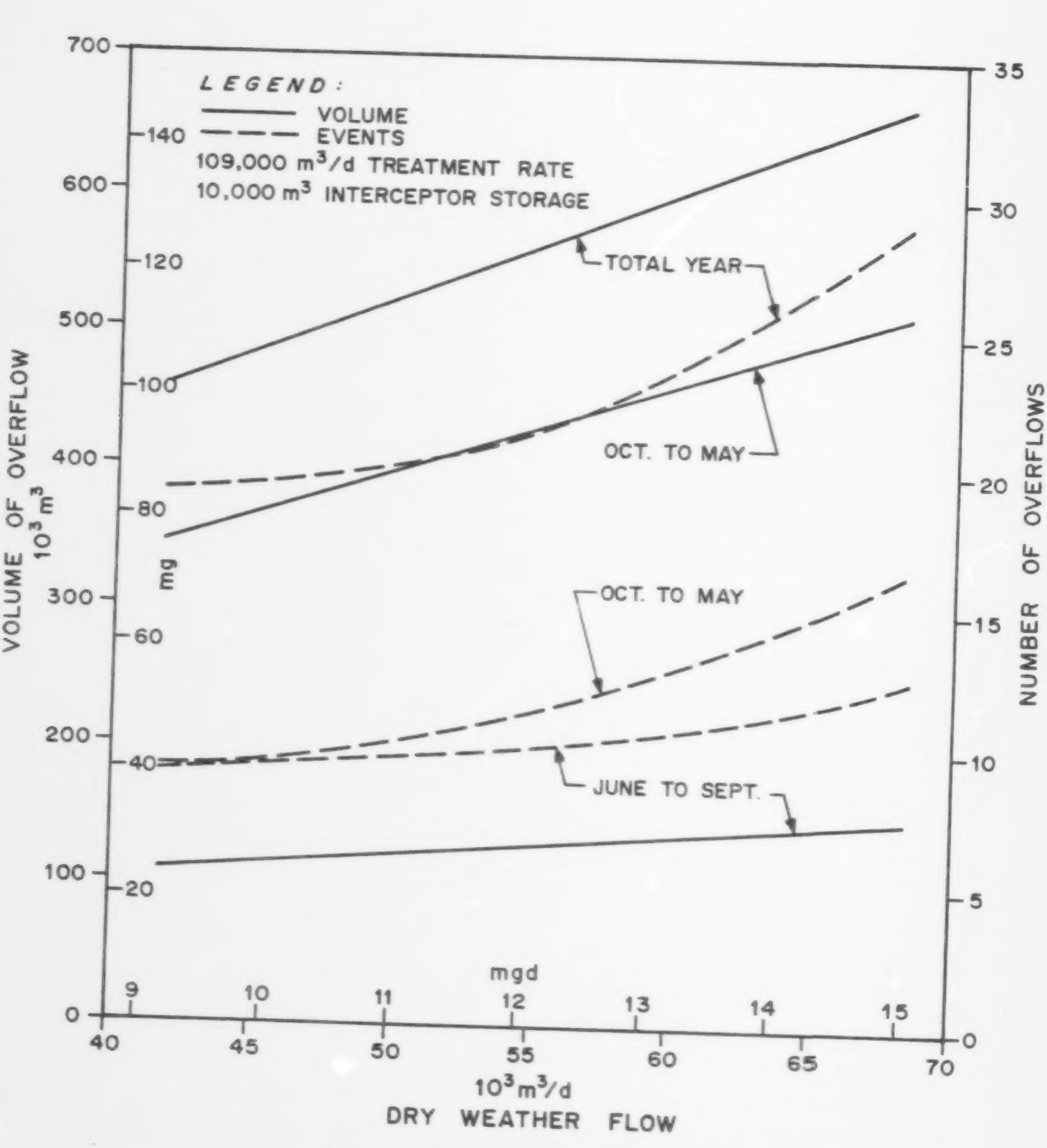


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FIGURE 10-5 — PROPOSED STORAGE TREATMENT COMBINATION VOLUME / NUMBER OVERFLOWS FOR INCREASING DRY WEATHER FLOWS

The analysis undertaken relating to quantities of flow was extensive and although both the present dry weather flow rates and average annual flow rates have been justified, a number of problem areas in the system were identified, which require both improvements to the system and continual monitoring, in order to more readily control and understand the system operation.

1. The monitoring programme pointed out areas with the separate sewer system where extraneous high rates of inflow were noted. Some of these problem areas were identified as part of this study and appropriate control measures were subsequently taken to eliminate the problems. However, other problem areas were not readily apparent and, "it is recommended that the City of Cornwall continue a programme of inspection and policing to eliminate illegal connections and extraneous flows to the separate sewer system".
2. It is deemed desirable to concentrate the combined sewer overflows to one location to such extent as this is possible. The analysis undertaken as part of this report indicates that with the possible exception of both the Pitt Street and the Amelia Street and Brookdale Ave. overflows, all other overflow structures may be closed and all flows from these tributary areas directed into the Riverfront interceptor sewer. Any resulting overflows would then occur at the Brookdale Avenue overflow chamber.

This scheme will require increased intercepting capacity at each structure to match the capacity of the tributary sewers. At both Pitt Street and Amelia Street, an increased intercepting capacity of 3 times dry weather flow (3 x DWF) is proposed.

This proposed control scheme will require a detailed hydraulic analysis and "it is recommended that such analysis be undertaken as part of the final design report on the Water Pollution Control Plant expansion requirements".

Integration of Storage and Water Pollution Control Plant Operation

The recommended scheme relating to immediate requirements for the proper management and operation of this system in order to achieve a given level of control includes:

1. "Expansion of the present Water Pollution Conrol Plant facilities to provide treatment for a peak wet weather flow rate of 109,000 m^3/d."
2. In conjunction with the Water Pollution Conrol Plant expansion, "it is recommended that the Riverfront Interceptor sewer be utilized for additional storage, both to balance peak flow rates to the Water Pollution Control Plant and also to control the frequency and quantity of combined sewer overflow to the St. Lawrence River."

Industrial Waste Component of Sewage Flow

Both the analysis undertaken as part of this study and the operational experience at the Water Pollution Control Plant, shows that the industrial contribution component of the total sewage flow is particularly significant from the point of view of sewage strength.

One of the large influencing factors relating to the industrial sewage strengths, is the BOD component, which is relatively high in concentration and largely in a soluble form. It is, therefore, not readily removable by the primary treatment process at the Water Pollution Control Plant.

Recent efforts, both by the City and the Ministry of the Environment, have identified the major problem contributing industries and some remedial action has been carried out, particularly over the period of the past year. "These efforts should be continued, with an overall objective of reducing industrial discharge to the sewer system to within City By-law limits." It is recognized that this will be a long and difficult process but one which will be most worthwhile.

Street Sweeping Practices

Watershed management principles and, more particularly, street sweeping practices were investigated and it is noted that the City of Cornwall presently undertakes a very effective street sweeping program, particularly with the downtown commercial and central business district core area.

"It is recommended that the City of Cornwall continue with their present programme of street sweeping and, at the same time, it is noted that any improvement in the present street sweeping programme will have some beneficial effect, with respect to pollutant discharge to the receiving waters".

10.7.2 Capital Costs

Costing was carried out only for the storage/treatment capital items.

In accordance with the recommendations contained in this report and the foregoing discussion, estimated costs for the immediate requirements are in the amount of approximately $4,746,000 (1980) summarized as follows:

1. New Water Pollution Control Plant Expansion Facilities to provide a peak rate capacity of 109,000 m^3/d	$4,192,000
2. New Sewage Pumping Station Inlet Chamber and overflow, together with hydraulically operated control gate	244,000
3. New hydraulic grade line (water level) monitoring facilities for Riverfront Interceptor Sewer, including transmitting to WPCP and automatic control of Interceptor Sewer gates	150,000
4. New hydraulic operated control gate at Brookdale overflow chamber for River Backwater control	60,000
5. Modification to existing intercepting chambers to increase intercepting capacity and closing of various overflows	100,000
TOTAL (1980)	$4,746,000

CHAPTER 11

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APPENDIX A

GLOSSARY OF TECHNICAL TERMS

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GLOSSARY OF TECHNICAL TERMS

ADVANCED TREATMENT - process or method for supplementary treatment of sewage and other wastes beyond the quality achieved by conventional secondary treatment.

AGRICULTURE - all lands including structures actively committed to the production of food and fibre.

ASSIMILATIVE CAPACITY - the ability of a water body to transform and/or incorporate substances (e.g. nutrients) by the ecosystem, such that the water quality does not degrade below a predetermined level.

BIOACCUMULATION - the uptake and retention of contaminants by an organism from its environment.

BOUNDARY WATERS - for the purposes of the Boundary Waters Treaty, boundary waters are defined as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers and waterways, or the waters of rivers flowing across the boundary (L. Michigan is not considered to be part of the Boundary Waters).

CATCHMENT - surface drainage area.

CHEMICAL MATERIALS - substances obtained by or used in processes in industry and agriculture including heavy metals, salts, petroleum products and radioactive wastes.

COMBINED SEWER - a sewer intended to carry surface runoff, sewage and industrial wastes allowed by sewer by-laws.

COMBINED SEWER OVERFLOW - flow from a combined sewer in excess of the interceptor capacity that is discharged into a receiving water.

CONSERVATIVE POLLUTANT - a pollutant that retains one form in the receiving water (e.g. chloride, sodium, etc.).

CONVENIENCE - the condition of availability or accessibility of a facility, such as roadway, for its intended purpose without nuisance or unfavorable conditions, such as would be caused by flooding. A "level of convenience" refers to the frequency of occurrence of nuisance conditions, such as would result from a storm with a known frequency of occurrence.

COST-EFFECTIVE - answering the purpose of providing the optium effect at the most reasonable cost.

CRITERION, WATER QUALITY - a designated concentration of a constituent, based on scientific judgements, that, when not exceeded will protect an organism, a community of organisms, or a prescribed water use with an adequate degree of safety.

DESIGN STORM - a rainfall of specified amount, intensity, duration, pattern over time, and frequency as a design basis.

DRY WEATHER FLOW - combination of domestic sewage and industrial and commercial wastes found in sanitary sewers during the dry weather season of the year.

DETENTION - the slowly, dampening, or attenuating of flows either entering the sewer system or within the sewer system by temporarily holding the water on a surface area, in a storage basin, or within the sewer itself.

EFFLUENT - the wastewater discharged to a receiving water body following sewage treatment and/or industrial processing.

EROSION - the processes by which the ground surface is worn away by the action of wind and water; also the process by which the bed and banks of a stream are worn away by the action of water.

EQUALIZATION - the averaging (or method for averaging) of variations in flow and composition of a liquid.

EUTROPHICATION - the progressive enrichment of surface waters, particularly nonflowing bodies of water such as lakes and ponds, with dissolved nutrients, such as phosphorus and nitrogen compounds, which accelerate the growth of algae and higher forms of plant life and result in the utilization ofthe usable oxygen content of the waters at the expense of other aquatic life forms.

EXFILTRATION - the escape of water from a water main or sewage from a sewer, into subsurface materials due to a break, leaks, etc., in the pipe.

FIRST FLUSH - the condition, often occurring in storm sewer discharges and combined sewer overflows, in which a disproportionately high pollution load is carried in the first portion of the discharge or overflow.

FLOOD PLAIN - the area of ground along a stream course that is covered by water at flood stage.

FORESTED AREAS - includes those regions of the basin where the dominant activity is directed towards the growth, management and eventual harvesting of trees both deciduous and coniferous.

FOUNDATION DRAIN - a pipe or series of pipes that collects water drained from the foundation or footing of structures and discharges these waters into sanitary, combined or storm sewers or to other points of disposal, for the purpose of draining unwanted waters away from such structures.

INFLOW-INFILTRATION (I/I) - Inflow is defined as the gross influx of wet weather flows into a sanitary sewer. Sources of inflow include roof leaders, cross-connections (storm to sanitary) and directly connected catch basins.

Infiltration is the seepage in dry or wet weather or both of groundwater or vadose water into any sewer (storm, sanitary, combined). Generally, infiltration enters through cradeed pipes, poor pipe joints or cracked or poorly jointed manholes.

LIQUID WASTE DISPOSAL - the application of municipal and industrial wastewater effluents such as sewage sludge, industrial effluents and sludges and wastewaters from individual home waste treatment systems to land.

SOLID WASTE DISPOSAL - the disposal of municipal solid waste from residential, commercial and industrial activities, either in sanitary landfill sites or in other forms of land disposal.

DEEPWELL DISPOSAL - the practice of injecting wastes with limited alternative means of disposal into subsurface geological formations.

MAJOR SYSTEM - the route followed by storm runoff when the minor system is either inoperative or inadequate. It generally should consist of roads and major drainage channels.

MINOR SYSTEM - the drainage pipes, roadway gutters, enclosed conduits, and roof leader connections designed to convey runoff from frequent, less intense storms, to eliminate or minimize inconvenience in the area to be developed.

MIXING ZONE - an area of water contiguous to a point source, where exceptions to water quality objectives and conditions otherwise applicable to the receiving water may be granted.

NON-CONSERVATIVE POLLUTANT - a pollutant that can exist in more than one form (e.g. nitrogen, BOD_5, etc.).

NON-POINT SOURCE - an area from which pollutants are exported in a manner not compatible with practical means of pollutant removal (e.g. crop lands).

NUTRIENTS - for the purpose of this report, this term is restricted to a description of the primary nutrients, nitrogen and phosphorus.

PESTICIDES - an agent (usually a chemical) used to destroy or inhibit undesirable plants, fungi, animals (vertebrate and invertebrate) and bacteria.

PHYSICAL-CHEMICAL TREATMENT PROCESS - means of treatment in which the removal of pollutants is brought about primarily by chemical clarification in conjunction with physical processes.

POLLUTANT - dredged soil, solid waste, incinerator residue, sewage, garbage, sludge, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, dirt and industrial, municipal and agricultural waste discharged into water.

PRIMARY TREATMENT - process or methods that serve as the first stage treatment of sewage and other wastes, intended to remove suspended and settleable solids by gravity and sedimentation. It provides no changes in dissolved and collodial matter in the sewage or waste flow.

RATIONAL METHOD - means of computing storm drainage flow rates using the formula $Q = CIA$, where C is a coefficient describing the proportion of rainfall expected to run off based on the physical characteristics of the drainage area, I is the rainfill intensity, and A is the area.

RECREATIONAL AREAS - the use of land and water resources for rest, relaxation and recuperation, including a variety of sports and other activities on public and private lands so designated for that purpose; including parks, cottage subdivisions, high-density, nonsewered residential areas, intensive recreational land use, ski slopes and recreational beaches.

REGULATION - a specific law that legally applies in all relevant situations.

RETENTION - the prevention of runoff from entering the sewer system by storing on a surface area or in a storage basin.

ROOF LEADER - a drain or pipe that conducts storm water from the roof of a structure, downward and into a sewer for removal from the property, or onto or into the ground for disposal by seepage.

RUNOFF - that portion of the precipitation on a drainage area that is discharged from the area into stream channels.

RUNOFF COEFFICIENT - fraction of rainfall that appears as runoff after subtracting depression storage and interception. Typically accounts for infiltration into ground and evaporation.

SANITARY SEWER - a sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with relatively low quantities of ground, storm, and surface waters that are not admitted intentionally.

SECONDARY TREATMENT - processes or methods for the supplemental treatment of sewage and other wastes, usually following primary treatment, to effect additional improvement in the quality of the treated wastes by biological means of various types.

SEDIMENT - soils or other surface materials transported by wind or water as a result of erosion.

SEDIMENTATION - the process of subsidence and deposition of suspended matter carried by water, sewage, or other liquids, by gravity.

SEWERSHED - the area of a municipality served by a given sewer network. For example, the area tributary to a given combined sewer overflow or a given WPCP would termed the sewershed tributory to the overflow or WPCP.

SIMULATION - representation of physical systems and phenomena by mathematical models.

STORM SEWER - a sewer that carries storm water and surface water, street wash and other wash waters or drainage, but excludes sewage and industrial wastes.

STORM SEWER DISCHARGE - flow from a storm sewer that is discharged into a receiving water.

STORM WATER - water resulting from precipitation which either percolates into the soil, runs off freely from the surface, or is captured by storm sewer, combined sewer, and to a limited degree sanitary sewer facilities.

SURCHARGE - the flow condition occurring in closed conduits when the sewer is pressurized or the hydraulic grade line is above the crown of the sewer.

TERTIARY TREATMENT - same meaning as advanced treatment.

TRANSPORTATION - the movement of people and good for social and economic purposes involving the use of machines or equipment including highways and roads, railroads, airports and utility corridors (transmission lines, pipelines).

URBAN DRAINAGE OR URBAN DRAINAGE SYSTEM - includes both man-made and natural elements. An urban drainage network consists of two systems: sanitary and storm sewers.

URBANIZED AREA - Central city, or cities, and surrounding closely settled territory. Central city (cities) have population of 50,000 or more. Peripheral areas with a population density of one person per acre or more are included (United States city definition).

URBAN RUNOFF - surface runoff from an urban drainage area that reaches a stream or other body of water or a sewer.

WATERSHED - the region drained by or contributing water to a stream, lake, or other body of water.

WATER TABLE - the upper level of the free groundwater in a zone of saturation, except when separated from an underlying groundwater by unsaturated material.

WATER TREATMENT/WATER PURIFICATION - the processes or method by which "raw" water is treated to remove bacteria, and possibly algae, colour, suspended material or other impurities in order to meet the minimum water quality objectives for human consumption.

WET WEATHER FLOW - a combination of dry weather flows, infiltration and inflow which occurs as a result of rain and storms.

APPENDIX B

SUMMARY OF MODELS POTENTIALLY APPLICABLE TO THE DETAILED ASSESSMENT PHASE OF THE PCP PROCESS

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SUMMARY OF MODELS POTENTIALLY APPLICABLE TO THE DETAILED ASSESSMENT PHASE OF THE PCP PROCESS

B-1 General

Brandstetter et al (1976) reviewed urban hydrologic models and summarized major features of the various models. This summary is presented in Table B-1. In general, all of the models listed combine runoff from several catchments and route the wastewater within the sewer system. Some of the models include wastewater quality and receiving water quality prediction capability.

Applicable non-point source models have been catalogued by Marshall, Macklin and Monaghan Limited (1977). Two categories of methods are reviewed; i.e. (1) indirect methods which utilize water quality parameter measurements to infer the importance of the non-point pollutant loadings and (2) direct methods which focus on the non-point sources and model the transport of pollutants to the receiving water. A partial listing of some of these evaluation techniques is presented in Table B-2. For further detail the original references should be consulted.

Some of the simulation models for which Ontario experience exists are summarized in Table B-3. The list is derived from information provided by Heathcote (1981a). Many of these models have been utilized by the MOE Water Resources Branch.

The model configurations that have been most widely utilized in Ontario for detailed assessments are (1) Storage Treatment Overflow and Runoff Model (STORM) coupled with a steady-state dissolved oxygen model, (2) STORM coupled with a dynamic water quality model and (3) Stormwater Management Model (SWWM). The basic concepts and examples of the application of these models will be discussed in the following. Most of these descriptions are taken directly from Singer (1979).

B-2 STORM Model Coupled with a Steady-State DO Model

The Storage Treatment Overflow and Runoff Model (STORM) was designed to evaluate the quantity and quality of urban runoff. STORM currently enjoys the most extensive use of any urban drainage simulation model. The

TABLE B-1
COMPARISON OF MAJOR URBAN RUNOFF MODELS
(Brandstetter et al, 1976)

	MODEL ORIGIN	MODEL ABBREVIATION	YEAR	CATCHMENT HYDROLOGY							SEWER HYDRAULICS								WASTEWATER QUALITY									MISCELLANEOUS					
				MULTIPLE CATCHMENT INFLOWS	DRY-WEATHER FLOW	INPUT OF SEVERAL HYETOGRAPHS	SNOWMELT	RUNOFF FROM IMPERVIOUS AREAS	RUNOFF FROM PERVIOUS AREAS	WATER BALANCE BETWEEN STORMS	FLOW ROUTING IN SEWERS	UPSTR AND DOWNSTR FLOW CONTROL	SURCHARGING AND PRESSURE FLOW	DIVERSIONS	PUMPING STATIONS	STORAGE	PRINTS STAGE	PRINTS VELOCITIES	DRY-WEATHER QUALITY	STORMWATER QUALITY	QUALITY ROUTING	SEDIMENTATION AND SCOUR	QUALITY REACTIONS	WASTEWATER TREATMENT	QUALITY BALANCE BETWEEN STORMS	RECEIVING WATER FLOW SIMULATION	RECEIVING WATER QUALITY SIMULATION	CONTINUOUS SIMULATION	CAN CHOOSE TIME INTERVAL	DESIGN COMPUTATIONS	REAL-TIME CONTROL	APPLIED TO REAL PROBLEMS	COMPUTER PROGRAM AVAILABLE
1	BATTELLE NORTHWEST	BNW	[illegible]	●	●	●		●	●		●		●	●		●	●	●	●	●	●			●					●	●	●	●	●
2	BRITISH ROAD RESEARCH LAB	RRL	[illegible]	●	●	●		●			●															●			●			●	●
3	CHICAGO SANITARY DISTRICT	FSP	[illegible]	●	●	●	●	●	●	●	●					●	●									●		●	●			●	●
4	CH2M-HILL	SAM	[illegible]	●	●	●		●	●	●	●		●	●	●		●												●				
5	CITY OF CHICAGO	[illegible]	[illegible]	●	●	●		●	●	●	●		●	●				●	●	●				●		●		●	●	●		●	●
6	COLORADO STATE UNIVERSITY		[illegible]	●	●			●			●	●					●	●															●
7	CORPS OF ENGINEERS	STORM	[illegible]				●	●	●	●				●		●				●			●		●			●				●	●
8	DORSCH CONSULT	HVM-QQS	[illegible]	●	●	●		●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●		●			●	
9	ENV PROTECTION AGENCY	SWMM	[illegible]	●	●	●		●	●		●	●	●	●	●	●			●	●	●	●	●	●		●	●		●	●		●	●
10	HYDROCOMP	HSP	[illegible]	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●		●		●	●	●	●	●		●	●	
11	ILLINOIS STATE	ILLUDAS	[illegible]	●	●	●		●	●		●					●	●												●	●			●
12	MIT-RESOURCE ANALYSIS	MITCAT	[illegible]	●	●	●	●	●	●		●		●	●		●	●	●								●			●			●	
13	MINNEAPOLIS-ST. PAUL	[illegible]	[illegible]	●	●	●		●	●		●			●															●		●	●	●
14	NORWEGIAN WATER RES.	NIVA	[illegible]	●	●						●	●	●	●	●	●			●	●	●			●				●	●	●			
15	QUEEN'S UNIVERSITY	QUURM	[illegible]	●				●	●		●																						
16	SEATTLE METRO	CATAD	[illegible]	●	●	●		●	●	●	●	●	●	●	●	●	●												●		●	●	●
17	SOGREAH	CAREDAS	[illegible]	●	●			●	●		●	●	●	●	●	●	●	●			●					●	●		●			●	
18	UNIVERSITY OF CINCINNATI	UCUR	[illegible]	●				●	●		●															●			●				●
19	UNIVERSITY OF ILLINOIS	ISS	[illegible]	●	●		●	●	●		●	●		●	●	●	●	●											●	●			●
20	UNIVERSITY OF MASSACHUSETTS		[illegible]	●	●			●		●	●	●					●	●										●					●
21	UNIVERSITY OF NEBRASKA	HYDRA	[illegible]	●		●		●	●		●																		●				
22	WATERMATION	[illegible]	[illegible]	●	●	●		●	●		●	●	●	●	●	●	●	●	●	●	●			●					●	●	●	●	
23	WATER RESOURCES ENGINEERS	STORMSEWER	[illegible]	●	●	●		●	●		●	●	●	●	●	●	●	●	●	●	●		●			●	●		●			●	
24	WILSEY AND HAM	[illegible]	[illegible]	●				●	●		●																		●	●		●	

TABLE B-2

NON POINT SOURCE EVALUATION TECHNIQUES

Technique	Brief Description	Reference
Agricultural Runoff Management (ARM) Model	Simulates runoff, snowmelt, soil loss, pesticide-soil interactions and soil nutrient transformations on small agricultural watersheds.	Donigan (1976)
Feedlot Runoff Model	Evaluate performance of feedlot control facilities on site-specific basis.	Zovne et al (1977)
Non Point Source Pollutant (NPS) Model	Simulates processes of pollutant accumulation, generation and runoff from land surface	EPA (1976)
Universal Soil Loss Equation	Predicts soil loss as a function of precipitation, soil characteristics, topography, cropping practices and erosion control practice	EPA (1973)
Storm Water Management Model (SWMM)	Described in text	
Storage Overflow and Treatment Model (STORM)	Described in text	
Hydrocomp Simulation Program (HSP) Model	Continuous simulation program for storm runoff	Hydrocomp (1976)
Multi-Resource System Model	A simulation model for examining the physical, economic and environmental consequences of alternative land-use decisions.	Bare et al (1977)
Pesticide Transport and Run-off Model	Quantifies pesticide runoff as a function of pesticide and soil properties, agricultural practices, watershed characteristics and climate factors	Hydrocomp (1973)

TABLE B - 3

PARTIAL LISTING OF SIMULATION MODELS POTENTIALLY USEFUL FOR PCS DETAILED ASSESSMENTS

MODEL	DEVELOPED BY	TYPE	USAGE	COMMENTS
a) Hydrologic Hymo	USDA & Texas A&M University	Steady State One Dimensional	Daily Simulation of Stream Flows	
Answers	US-EPA (Georgia)	Steady State Distributed (Grid) Type	Simulation of Precipitation and other Meterological Data to Generate Stream Flows	
HEC-5	Hydrologic Engineering CTR (US Corps of Engineers, Davis Calif.	Steady State One Dimensional	Flood Routing	
MOE Hydr	Water Modelling Water Resources MOE	Steady State One Dimensional	Daily and Hourly Simulation of Stream Flows	
TVA Model	Tennessee Valley Authority	Steady State One Dimensional	Daily Stream Flow Prediction	
HEC-2	Same as HEC-5	Steady State One Dimensional	Prediction of Water Levels Under Given River Conditions (Backwater Model)	
b) Water Quality Qual II	US-EPA (Georgia)	Steady State One Dimensional	Predict River Water Quality, up to 13 Parameters. Includes Bacteria and Algal Dynamics	Can be Run as Dynamic Model For Time Varying Meterological Data. Not Reliable for Some Parameters (BOD and NH_3)
HSPF	Hydrocomp Inc.	Steady State One Dimensional	Predict Water Quality and Quantity, Detailed Treatment of Reservoirs and Sediment Transport	Entire Model Costly to Run. Individual Modules are Useful.
HEC-6	Same as HEC-5	Steady State One Dimensional	Erosion and Sediment Transport and Deposition in Rivers and Reservoirs	Weak Scour Component
Exams	US-EPA (Georgia)	Steady State Compartmental Type	Lake and River Quality Modelling Degradation of Organic Compounds Detailed Chemical Processes	Limited Hydraulic Capability
DOMOD7	Water Modelling Water Resources MOE	Steady State One Dimensional	River Water Quality, Streeter-Phelps Type DO/BOD Model Which Incorporates Plant Growth Subroutine "ECOL 1"	Inexpensive to run, Easy to Apply, Several Versions Availabl
GRSM (Grand River Simulation Model)	Water Modelling Water Resources MOE	Dynamic One Dimensional	River Water Quality, Dynamic and Long Term Simulation. Includes Plant Growth Component	Expensive to run if Many Segment used. Has Short Time Step.
Hamilton Harbour - Block Model	Water Modelling Water Resources MOE	Steady State One Dimensional	DO-BOD Model for Embayments	Inexpensive to Run. Two Layer Version Can be Run Also.
Toronto/Hamilton Harbour Models	Water Modelling Water Resources MOE	Steady State Depth Integration - Two Dimensional	Simulation of Harbour Water Movement and Chemical Fluxes	Costly to Run, Very Detailed 3 Dimensional Version Available.

computer program, model documentation, user's manual and guidelines, are available at the Water Resources Branch of MOE. Storm is designed for use with many years of continuous hourly precipitation records but can be used for individual storm events. The model employs an accounting scheme that, for each storm event, allocates runoff volumes to storage and treatment and notes those volumes exceeding storage or treatment capacities. Water quality is handled as a function of hourly runoff rates, with generated quantities of pollutants allocated to storage, treatment or release into receiving waters. Statistics are generated for each event and collectively for all events processed, including average annual values for runoff and pollutant loadings.

The St. Thomas Study (James F. MacLaren, 1980) is an example of the use of STORM in conjunction with a steady-state model to investigate the impact of urban runoff on a receiving water (Kettle Creek). The STORM model was used to generate pollutant loads from storm and combined sewered areas of St. Thomas during storm events.

B-3 STORM Model Coupled with a Dynamic Water Quality Model

Output from the STORM model can be used also as an input to a dynamic water quality model. Such an application has been carried out recently for the Grand River Basin Water Management and is discussed in Chapter 6.

B-4 SWMM Model

The Storm Water Management Model (SWMM) is the most widely used system analysis model in North America. The computer program, model documentation, user's manual and guidelines are available at the Water Resources Branch of MOE.

A large number of companies and consulting firms in Canada and the U.S.have acquired the SWMM package. Twice per year users meet to exchange experiences in application of SWMM and other models.

SWMM is a comprehensive mathematical model, capable of representing urban storm water runoff (Figure B-1). The model accepts any rainfall hyetograph and produces a runoff hydrograph for each modelled urban area. Continuous runoff quality graphs, called pollutographs, are computed on the basis of the volume of storm runoff, antecedent dry period, land use types, street sweeping frequency and sewer type. Real time flow routing is accomplished through a simulation of the physical sewer system.

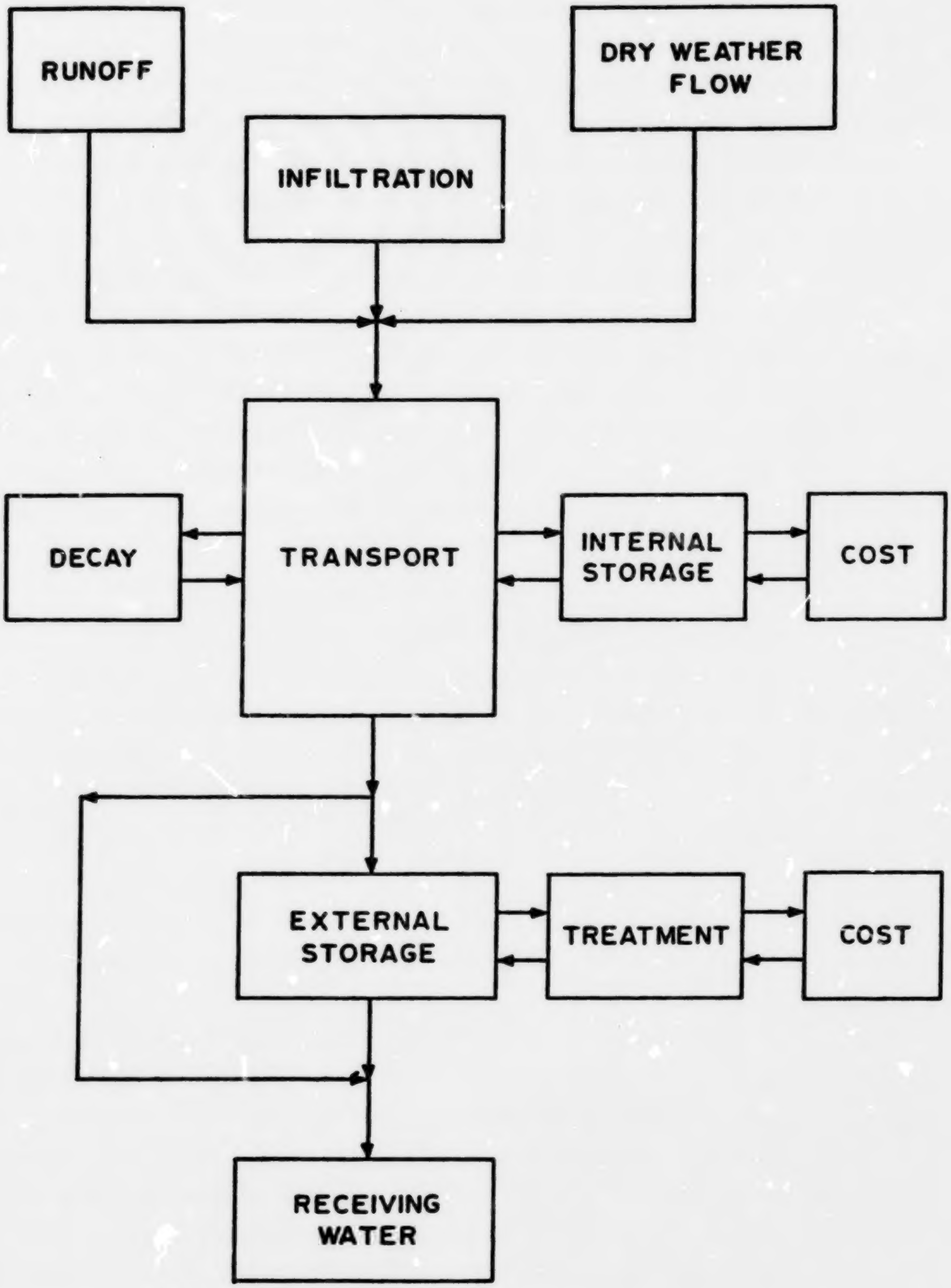
RUNOFF
INFILTRATION
DRY WEATHER FLOW
DECAY
TRANSPORT
INTERNAL STORAGE
COST
EXTERNAL STORAGE
TREATMENT
COST
RECEIVING WATER

FIGURE B-1 — SUBROUTINES OF STORMWATER MANAGEMENT MODEL (SWMM)

SWMM consists of a main control and service block - the Executive Block and four computational blocks: (1) Runoff Block, (2) Transport Block, (3) Storage Block, and (4) Receiving Water Block (Metcalf and Eddy, 1971).

The Executive Block assigns logical units, determines the block or sequence of blocks to be executed, and, on call produces graphs of selected results.

The Runoff Block computes the storm water runoff and its characteristics for a given storm for each subcatchment and stores the results in the form of hydrographs and pollutographs at inlets to the main sewer system.

The Transport Block performs flow and quality routing. It picks up the runoff results and produces combined flow hydrographs and pollutographs for the total urban area.

The Storage Block uses the output of the Transport Block and modifies the flow at a given point according to predefined storage and treatment requirements.

The Receiving Water Block accepts the output of the Transport Block directly, or the modified output of the Storage Block and computes the effects of the urban runoff pollution loads on the receiving river, estuary, lake or bay. The job is done through tracing or routing the pollutant and determining their temporal and spatial variation in the receiving system.

In principle, the capability exists to run all blocks together in a given computer execution. From a practical viewpoint however, typical runs involve one or two computational blocks together with the Executive Block. For example, the St. Thomas Study (James F. MacLaren, 1980) utilized the runoff and receiving water subroutines of SWMM for selected evaluations.

SWMM has been modified to Canadian conditions (Proctor and Redfern and James F. MacLaren, 1976) and elements of it have been tested for a watershed in Hamilton (Gore and Storrie, 1980) and urban area in the Borough of East York (M.M. Dillon Ltd., 1979).